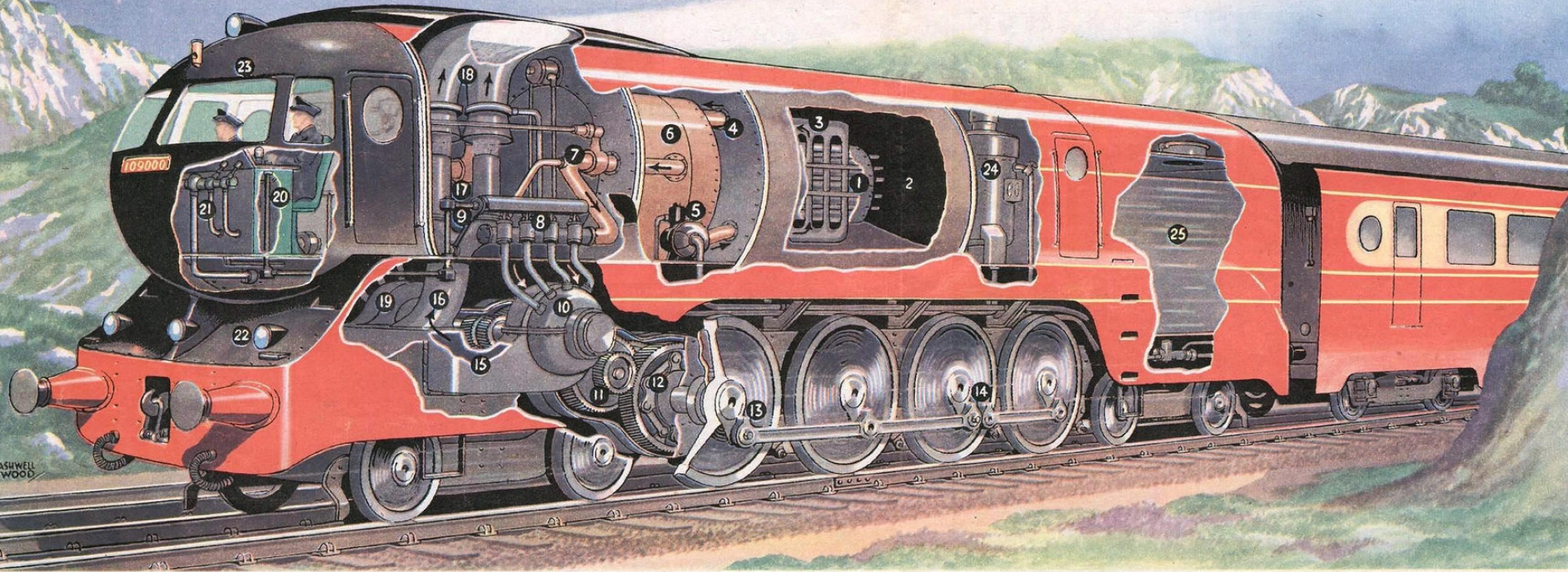


# THE ATOMIC LOCOMOTIVE



In this exclusive EAGLE drawing, our artist has given his impression of the shape of things to come.

Based on scientific facts, the atomic locomotive, using *Uranium 235*, is a possibility not so far distant as many suppose.

The power of the atom is harnessed to produce heat, to turn pressurized water into superheated steam, for driving turbines geared to the driving wheels.

This system does away with fuel and stoking, as the atomic force goes on more or less indefinitely.

A locomotive of this description could travel thousands of miles without refuelling, except for water.

## KEY TO HOW IT WORKS

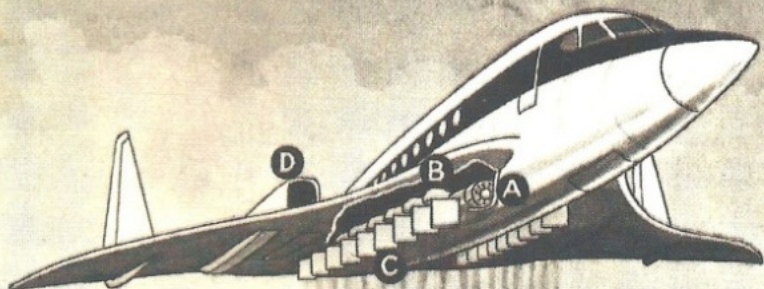
(1) Atomic reactor wherein the *Uranium 235* atoms are exploded by neutrons, generating great heat. (2) Heavy graphite shielding to prevent radiation. (3) Passages for cooling water drawing off the heat. (4) Superheated water to steam chest. (5) Pressurized water circulating pump. (6) Main steam chest. (7) Superheated steam pipe and control valve. (8) Turbine steam nozzles. (9) Nozzle control rod from driver's cab. (10) High pressure forward drive turbines. (11) Treble reduction gears. (12) Shock absorbers. (13) Driving wheels driven by gearing. (14) Drive transmitted to coupled wheels. (15) Turbine exhaust. (16) Exhaust to double blast pipes. (17) Double blast pipes. (18) Large diameter chimney opening for the low pressure exhaust. (19) Reverse turbine. (20) Driver's control cubicle. (21) Steam supply for auxiliaries. (22) Marker lights. (23) Streamlined cab casing, on aircraft construction principle. (24) Low pressure steam chest for train heating. (25) Cooling water tank.

LASHWELL  
WOOD

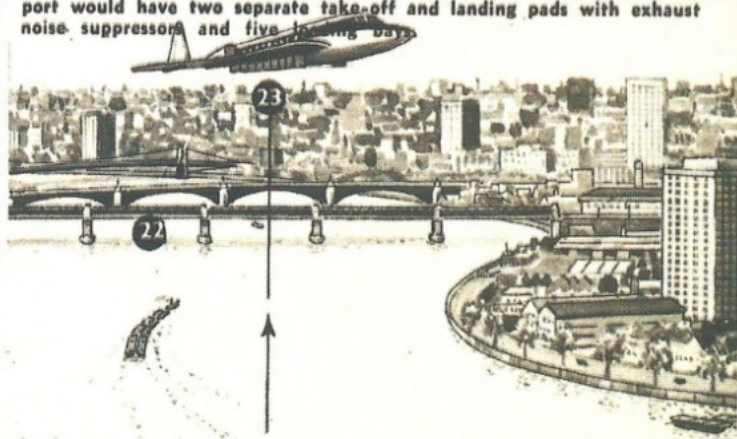


# Future Airport In London's Centre

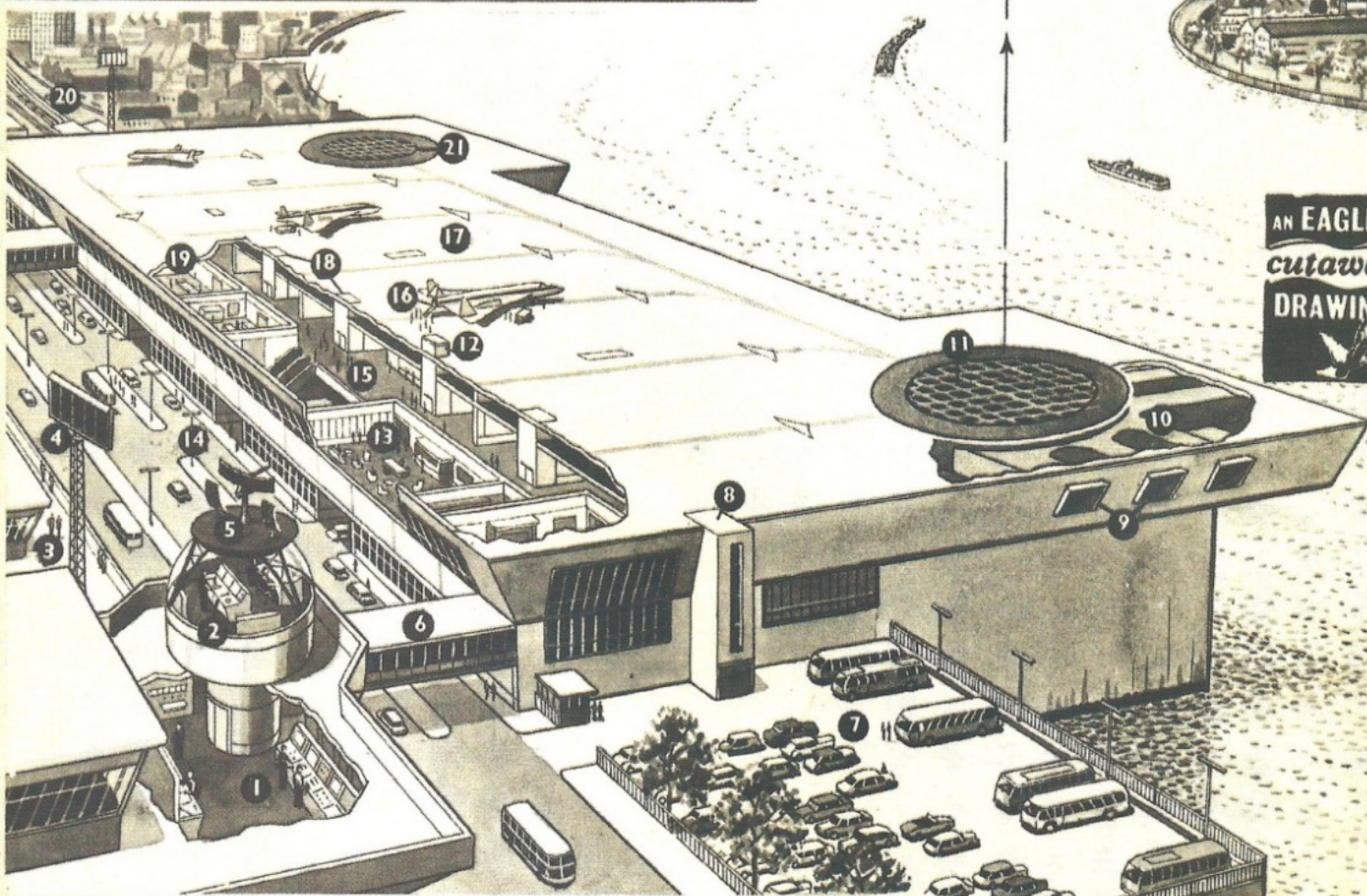
The ever-increasing delays in travelling between existing airports and city centres, like London and Paris, causes a barrier to fast air travel — even if the passenger goes by 600 m.p.h. jet! The answer is vertical take-off and landing (VTOL) airliners which will bring passengers to the city centres. The possibility of an airport site for these VTOL airliners, at Nine Elms on the South bank of the River Thames in the heart of London, has been studied by Hawker Siddeley Aviation. It would be used for inter-city travel, the major airports being utilized for the long-distance supersonic and airbus jets. The big problem for the city centre airport is defeating engine noise; this has brought about a design study for 'quiet' turboprop lift aircraft with wing-mounted lift pods used only during take-off and landing. Separate jet engines will take over for forward power. We show an impression of such a central airport as it might appear in the future with rail and bus services close at hand for reaching offices and hotels in London. The airport would have two separate take-off and landing pads with exhaust noise suppressors and five loading bays.



Proposed design for a 90-seat short-haul transport with wing-mounted lift pods for vertical take-off and landing. (A) Light-weight jet engines for lift. (B) Engine-driven turboprops which give lift and reduce engine noise by lowering the speed of the exhaust gases. (C) Lift ducts can be closed in forward flight. (D) Separate jet engines for forward power.



AN EAGLE  
cutaway  
DRAWING



## KEY TO NUMBERED PARTS

(1) Aircraft movement and plotting room. (2) Vertical take-off and landing control tower. (3) Public viewing gallery. (4) Floodlights. (5) Radar scanners. (6) Overbridge from airport offices and communications. (7) Car and coach park. (8) Lift for aircraft refuellers and ground equipment. (9) Take-off exhaust outlets. (10) Exhaust noise suppressors. (11) Take-off pad over the River Thames. (12) Passenger lift raised. (13) Passenger lounge and restaurant. (14) Separate drive in and entrances for passengers and baggage. (15) Main concourse and access to lifts. (16) Rear passenger entry to aircraft. (17) Airport apron with five loading bays. (18) Passenger lifts. (19) Customs and booking office. (20) Existing railway sidings at Nine Elms converted to passenger services to Victoria and Waterloo Stations. (21) Vertical landing pad with exhaust noise suppressors. (22) Victoria railway bridge. (23) Aircraft after vertical take-off transferring to forward flight over the river.

LASHWELL  
WOOD



# HOVERPORT OF THE FUTURE

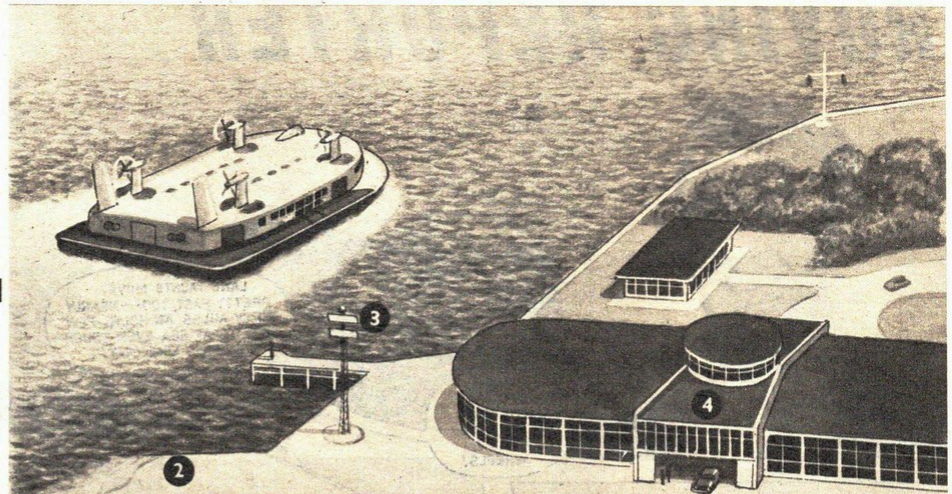
This is the design for a future Hoverport for a cross-channel car and passenger link by SR.N4 Hovercraft.

The existing forms of cross-channel transport by ship and aircraft would continue to carry the growth of traffic expected by the year 2,000. Beyond this level the hovercraft service could cater for a peak August daily traffic of 13,500 cars with a fleet of 16 SR.N4-type hovercraft by 1985.

Opening up the hovercraft routes across the Channel would avoid the congestion of traffic in the Dover-Calais areas.

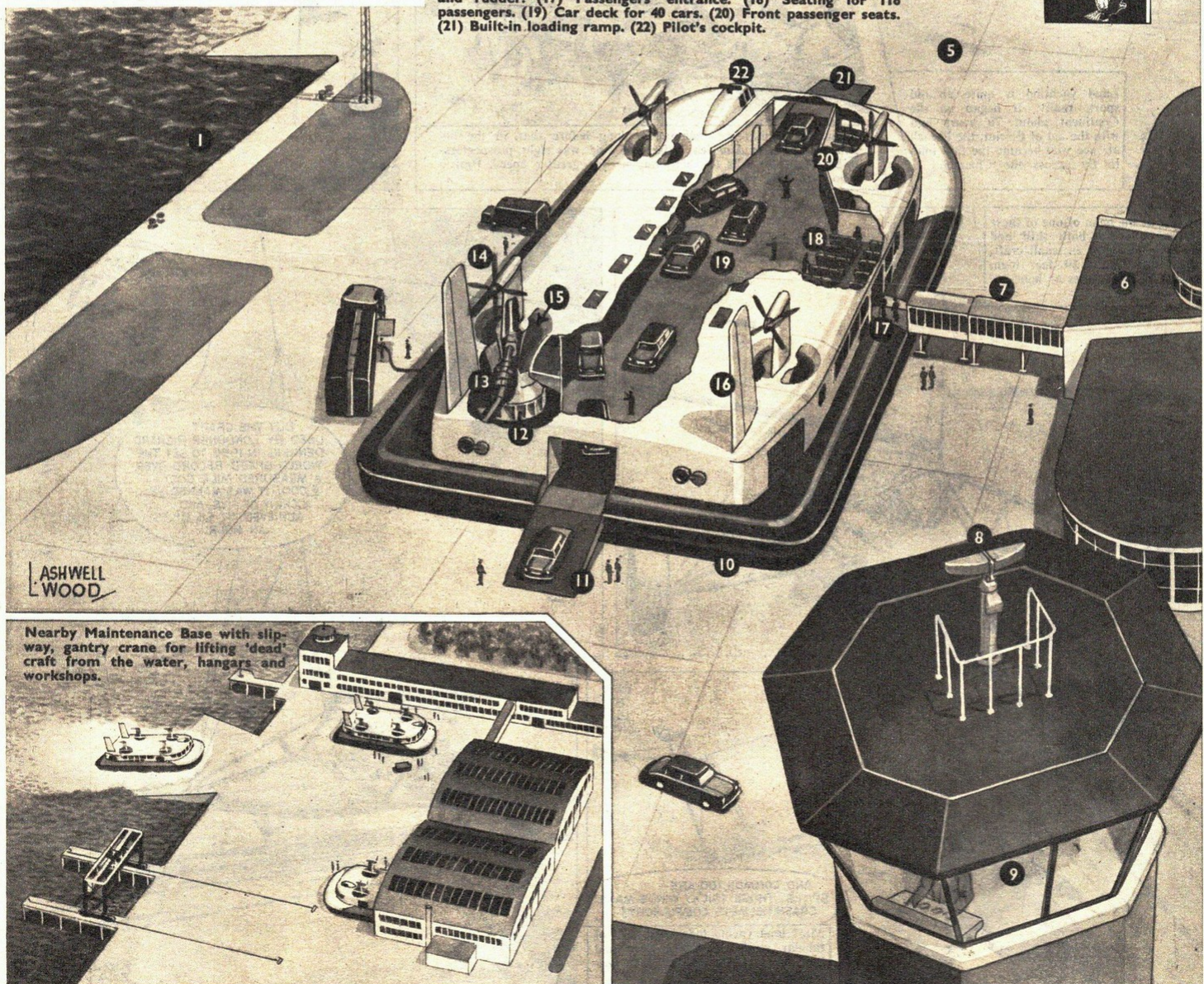
The projected hovercraft will travel at 77 knots in calm seas, down to 50 knots even in 6 to 8 ft. waves. They will weigh 170 tons and carry a load of 75 tons - 660 passengers (seated) or 116 passengers and 40 cars.

Four Bristol Siddeley Proteus gas-turbine engines, with totalling 14,000 h.p., will provide the lifting power and forward speed. Length - 128 ft. Beam - 83 ft.



## KEY TO NUMBERED PARTS

- (1) Hovercraft mooring bay. (2) Slipway (at high tide). (3) Floodlights. (4) Car and freight terminal. (5) Apron manoeuvring space. (6) Passenger concourse and restaurant. (7) Passenger gangway. (8) Radar scanner. (9) Control tower. (10) Lifting skirt. (11) Built-in unloading ramp. (12) Lifting air fan. (13) One of four Bristol Siddeley Proteus gas-turbine engines - 3,500 h.p. each. (14) Reversible pitch propellers. (15) Air inlets to lift fans. (16) Vertical fin and rudder. (17) Passengers' entrance. (18) Seating for 116 passengers. (19) Car deck for 40 cars. (20) Front passenger seats. (21) Built-in loading ramp. (22) Pilot's cockpit.



ASHWELL  
WOOD

Nearby Maintenance Base with slipway, gantry crane for lifting 'dead' craft from the water, hangars and workshops.



# AIRCRAFT WHICH GOES UNDER THE SEA!

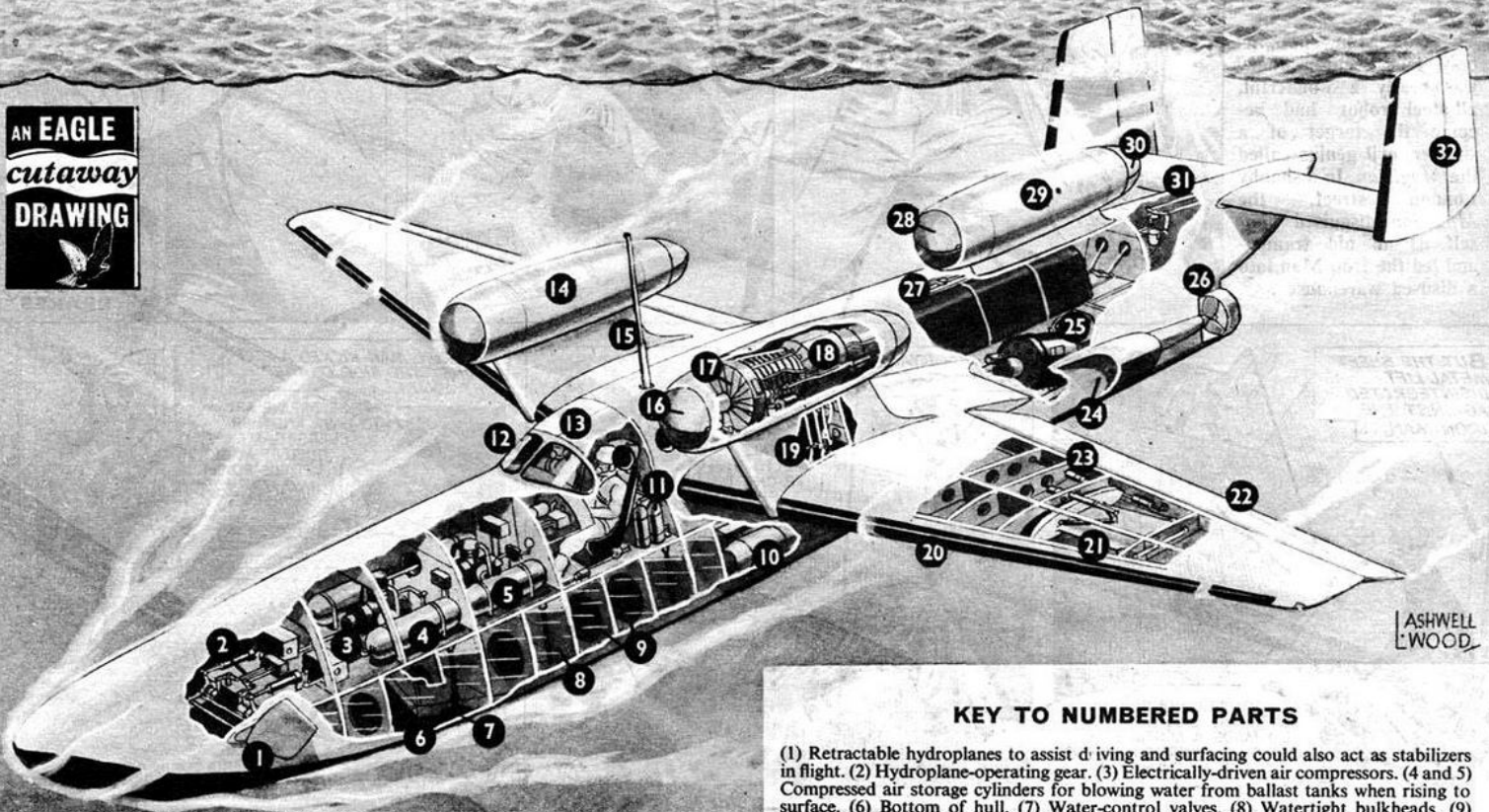
**A**FTER six months' study, the General Dynamics/Convair Company of the United States have said they are quite capable of building a flying boat that could travel through the air and *under* the sea. This fantastic machine, called a Sub-Plane, may become a real-life version of the TV 'Supercar'.

As the drawing shows, the Sub-Plane would be basically like a flying boat, with three turbo-jet engines mounted in pods above the wing and over the rear fuselage. In flight, the Sub-Plane would have a target range of nearly 600 miles at a speed of 260 m.p.h., with a half a ton payload.

Near the target, it would alight on the water. The pilot would make the jet engines watertight. Ballast tanks would be flooded and the Sub-Plane could sink to a depth of 75 feet, driven by an electric motor and batteries. The underwater speed would be five knots. The Sub-Plane's mission might be to attack enemy submarines or as a base for rescue or salvage work.



*The Sub-Plane in flight and about to alight on the water as a flying boat, with retractable wing-tip floats extended*



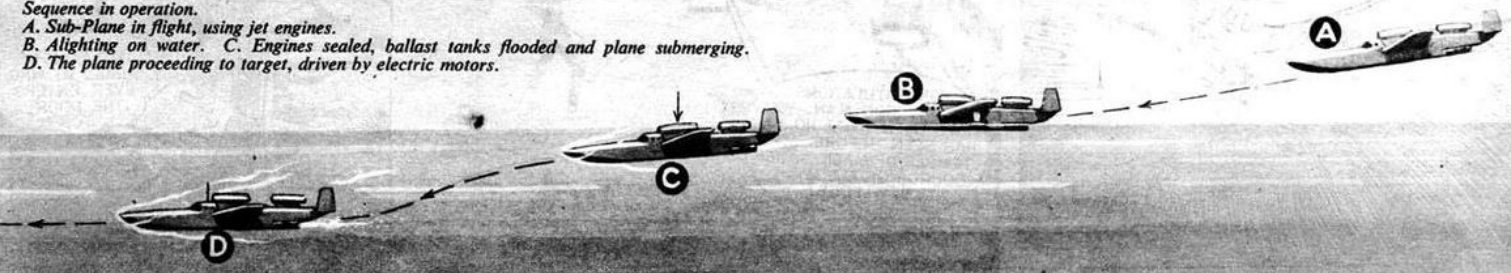
ASHWELL  
WOOD

## KEY TO NUMBERED PARTS

(1) Retractable hydroplanes to assist diving and surfacing could also act as stabilizers in flight. (2) Hydroplane-operating gear. (3) Electrically-driven air compressors. (4 and 5) Compressed air storage cylinders for blowing water from ballast tanks when rising to surface. (6) Bottom of hull. (7) Water-control valves. (8) Watertight bulkheads. (9) Ballast tanks flooded for submerging. (10) Depth charges for attack mission. (11) Oxygen-breathing apparatus. (12) Armoured glass look-out. (13) Crew escape-hatch. (14) Starboard turbo-jet engine. (15) Retractable lightweight periscope. (16) Front watertight engine seal (closed when submerged). (17) Engine air-intake in flight. (18) Port turbo-jet engine. (19) Engine controls. (20) Anti-icing strip. (21) Retractable wing-tip floats folded. (22) 'Elevons' - acting as elevators and ailerons in flight and driving controls when submerged. (23) Elevon control jacks. (24) Water-intake duct to propeller. (25) Electric propulsion motor. (26) Shrouded propeller for underwater propulsion. (27) Fuel tanks in fuselage. (28) Front watertight engine seal (closed). (29) Rear turbo-jet engine. (30) Rear watertight engine seal (closed). (31) Rudder controls. (32) Twin rudders. Normal flight controls would operate satisfactorily under water.

## Sequence in operation.

- A. Sub-Plane in flight, using jet engines.  
B. Alighting on water. C. Engines sealed, ballast tanks flooded and plane submerging.  
D. The plane proceeding to target, driven by electric motors.





# BARREL-WINGED TRANSPORT

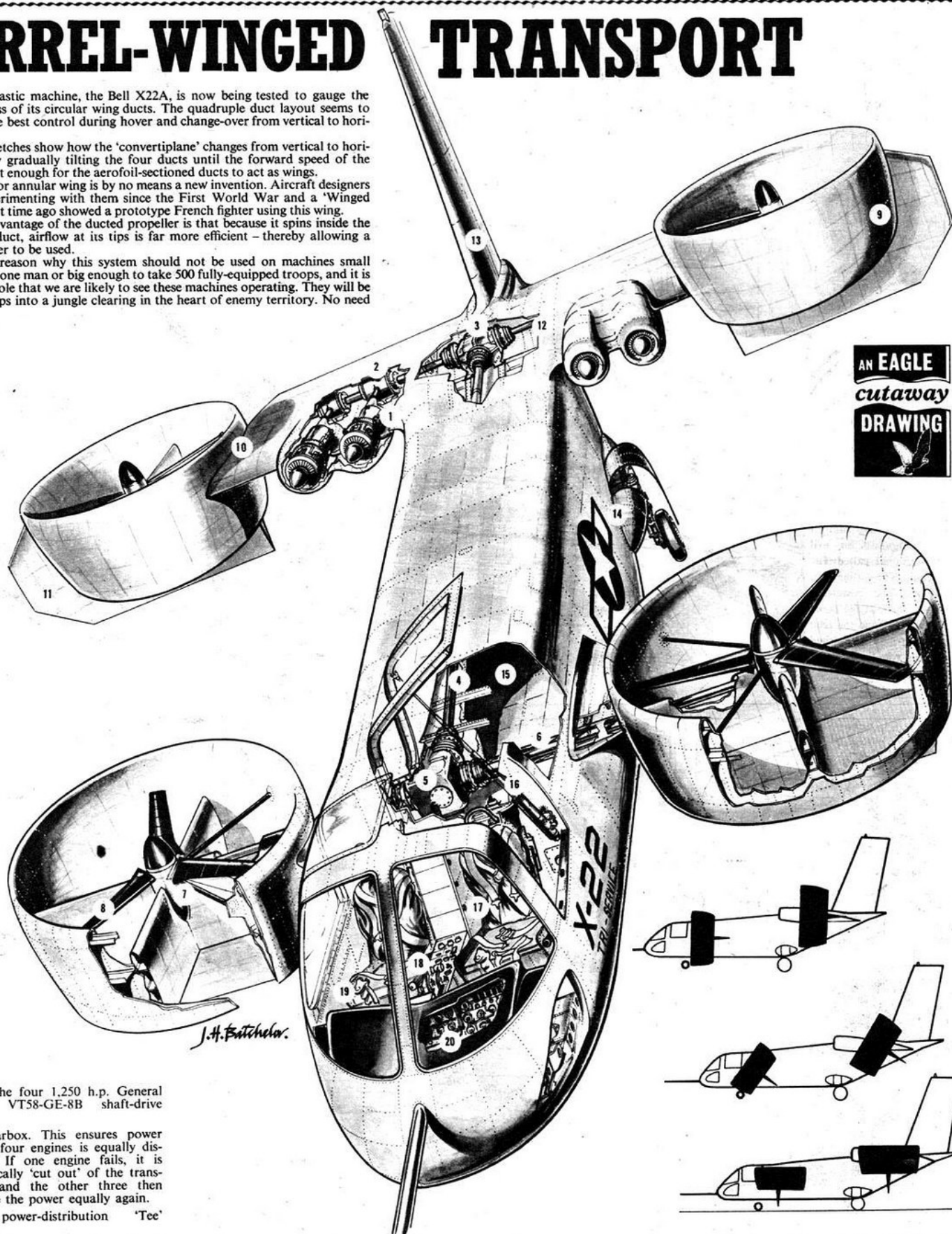
**T**HIS *FANT*astic machine, the Bell X22A, is now being tested to gauge the effectiveness of its circular wing ducts. The quadruple duct layout seems to provide the best control during hover and change-over from vertical to horizontal flight.

The small sketches show how the 'convertiplane' changes from vertical to horizontal flight by gradually tilting the four ducts until the forward speed of the machine is great enough for the aerofoil-sectioned ducts to act as wings.

The circular or annular wing is by no means a new invention. Aircraft designers have been experimenting with them since the First World War and a 'Winged Wonder' a short time ago showed a prototype French fighter using this wing.

One great advantage of the ducted propeller is that because it spins inside the barrel-shaped duct, airflow at its tips is far more efficient - thereby allowing a smaller propeller to be used.

There is no reason why this system should not be used on machines small enough to take one man or big enough to take 500 fully-equipped troops, and it is in this second role that we are likely to see these machines operating. They will be able to fly troops into a jungle clearing in the heart of enemy territory. No need for runways.



AN EAGLE  
cutaway  
DRAWING

## KEY

- (1) One of the four 1,250 h.p. General Electric VT58-GE-8B shaft-drive turbines.
- (2) 'Tee' gearbox. This ensures power from all four engines is equally distributed. If one engine fails, it is automatically 'cut out' of the transmission and the other three then distribute the power equally again.
- (3) Main power-distribution 'Tee' gearbox.
- (4) Shaft bringing power to forward end of machine through...
- (5) Secondary main 'Tee' box.
- (6) Shaft transmitting power to propellers in ducts.
- (7) Shaft drives propeller through 90 degree gears in pod.
- (8) Four 7-foot-diameter propellers which rotate at 2,590 r.p.m.
- (9) Each of the four ducts is like a wing

- (10) The ducts swing through 90 degrees to face either for lift (as they are now) or forward for horizontal flight.
- (11) More lifting area is provided behind and through the centre of each duct.
- (12) Drive shaft to duct.
- (13) Fin. This machine has no rudder.
- (14) Part of the main retractable undercarriage.
- (15) The interior of this particular machine has very little trim in it because it is purely for research.
- (16) Hydraulic rams lift side panels for entry and exit.
- (17) Crew of two sit in rocket-boosted ejector seats. In starboard seat sits the test pilot - port seat is used by second pilot.
- (18) Dual controls and instruments are installed.
- (19) Starboard joystick (port and starboard).
- (20) Part of mass of test instruments.



# A FLYING WING JET AIR-LINER OF THE FUTURE

Our artist's impression of a flying wing aircraft is based on scientific data and is quite within the realms of possibility. In fact an American 8 jet-propelled bomber - the Northrop YB-49 - is already built but still on the secret list. In the air-liner the whole of the cabin and cargo space is pressurized for high altitude flying at high speeds. Eight super-jet engines give adequate power. New type combined elevator-aileron controls counteract the tendency to a nose-down movement when the take-off and landing flaps are used. An aircraft of this type would fly non-stop by night to America or India with sleeping passengers.

## KEY TO NUMBERS

(1) Rudder and fin (port and starboard). (2) Side-slip indicator. (3) Exhaust vents for de-icing warm air. (4) Corrector for horizontal trim. (5) Aileron - elevator controller. (6) Trim tab. (7) Hydraulic operating gear. (8) Main spar. (9) Outer fuel tanks. (10) De-icing pipe from engines and air corrugations in leading edge of wing. (11) Air intakes to jet engines. (12) Four port super-jet engines. (13) Port undercarriage (retracted). (14) Inner fuel tanks. (15) Passengers' observation windows. (16)

Lounge. (17) Galley and pantry. (18) Radio operator and navigator. (19) Captain and first officer. (20) Flight engineer. (21) Dining room. (22) Four starboard super-jet engines. (23) Starboard undercarriage (retracted). (24) Two berth cabins. (25) Skylights and emergency exits. (26) Gentlemen's dressing room and toilet. (27) Ladies' dressing room and toilet. (28) Main entrance under wing. (29) Mails. (30) Freight. (31) Slotted flaps to assist take-off and landing. (32) Double skin of pressurized wing.



# THE HYDROFIN



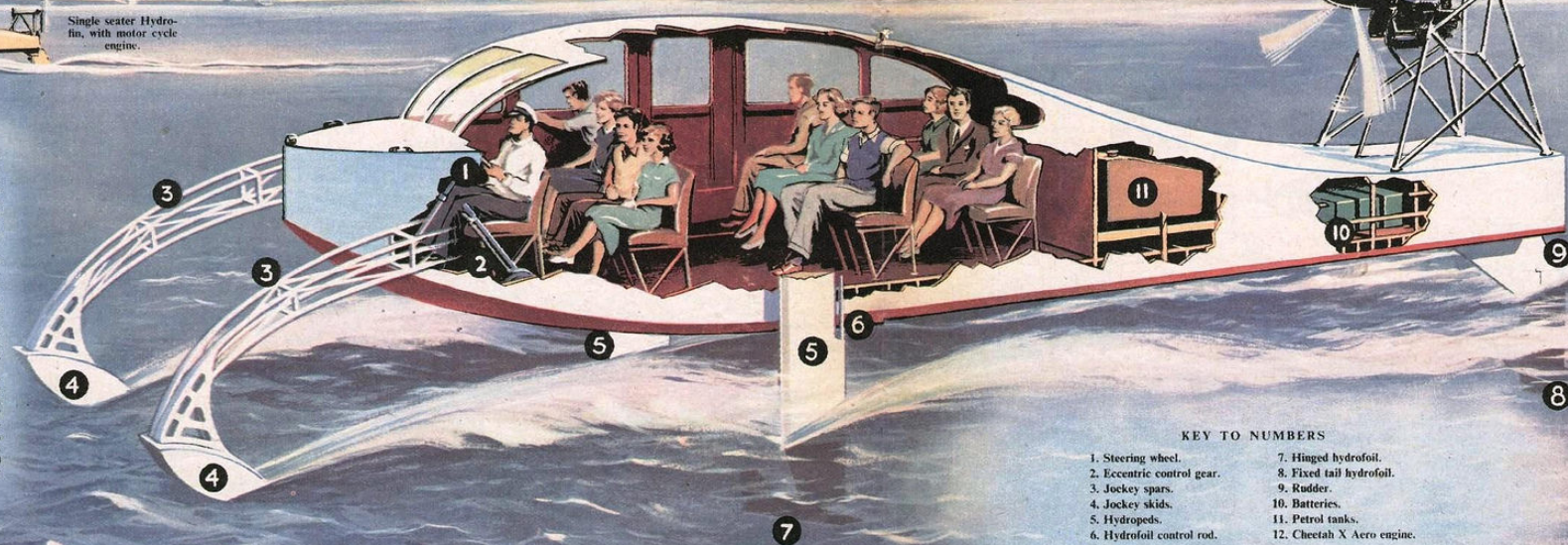
Single seater Hydrofin, with motor cycle engine.

Half ship and half aircraft, the Hydrofin is probably the oddest looking craft afloat. Invented by Mr Christopher Hook of Cowes, Isle of Wight, it is much faster than any surface ship and also far more economical than an airplane. It is thus very suitable for cross channel and inter-island service. For naval use, too, it has great possibilities, as it has little to worry about from mines or torpedoes.

The inclined plane, or aerofoil of the modern aeroplane, has its counterpart afloat in the hydrofin, and it is by this that the hull of the fast moving Hydrofin is lifted clear of the water. There is a hinged hydrofoil on each of the two forward "legs" or hydrofins and a fixed one aft. Linked to these front hydrofoils are the jockeys which, lightly skimming the water ahead, adjust the angle of the hydrofoils to meet oncoming waves.

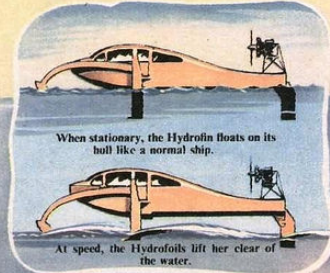
Hydrofins are fast becoming popular and a number have been built both in this country and abroad. The one shown is 30 ft. long and is designed to carry 12-15 passengers. Speeds of 50 to 80 m.p.h. can be attained according to the size of craft and engine fitted. In the distance is shown a small single-seater sports model. Powered by motor-cycle engines, these small craft are simple enough to be built at home by amateurs.

LAURENCE DUNN



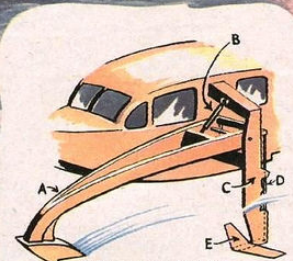
## KEY TO NUMBERS

- |                            |                            |
|----------------------------|----------------------------|
| 1. Steering wheel.         | 7. Hinged hydrofoil.       |
| 2. Eccentric control gear. | 8. Fixed tail hydrofoil.   |
| 3. Jockey spars.           | 9. Rudder.                 |
| 4. Jockey skids.           | 10. Batteries.             |
| 5. Hydrofins.              | 11. Petrol tanks.          |
| 6. Hydrofoil control rod.  | 12. Cheetah X Aero engine. |



When stationary, the Hydrofin floats on its hull like a normal ship.

At speed, the Hydrofoils lift her clear of the water.

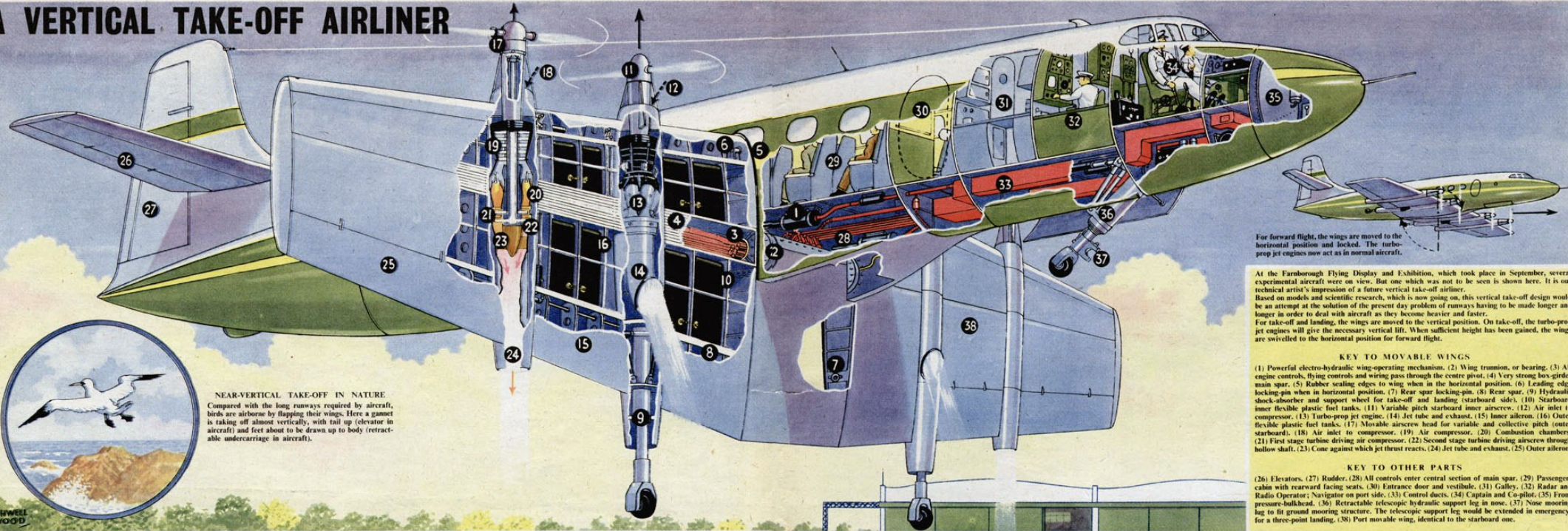


## KEY TO LETTERS

- A. Jockey spar; B. Dashpot; C. Hydrofins; D. Control rod; E. Hydrofoil.



# A VERTICAL TAKE-OFF AIRLINER



For forward flight, the wings are moved to the horizontal position and locked. The turbo-prop jet engines now act as in normal aircraft.

At the Farnborough Flying Display and Exhibition, which took place in September, several experimental aircraft were on view. But one which was not to be seen is shown here. It is our technical artist's impression of a future vertical take-off airliner.

Based on models and scientific research, which is now going on, this vertical take-off design would be an attempt at the solution of the present day problem of runways having to be made longer and longer in order to deal with aircraft as they become heavier and faster.

For take-off and landing, the wings are moved to the vertical position. On take-off, the turbo-prop jet engines will give the necessary vertical lift. When sufficient height has been gained, the wings are swivelled to the horizontal position for forward flight.

## KEY TO MOVABLE WINGS

(1) Powerful electro-hydraulic wing-operating mechanism. (2) Wing trunnion, or bearing. (3) All engine controls, flying controls and wiring pass through the centre pivot. (4) Very strong box-girder main spar. (5) Rubber sealing edges to wing when in the horizontal position. (6) Leading edge locking-pin when in horizontal position. (7) Rear spar locking-pin. (8) Rear spar. (9) Hydraulic shock-absorber and support wheel for take-off and landing (starboard side). (10) Starboard inner flexible plastic fuel tanks. (11) Variable pitch starboard inner airscrew. (12) Air inlet to compressor. (13) Turbo-prop jet engine. (14) Jet tube and exhaust. (15) Inner aileron. (16) Outer flexible plastic fuel tanks. (17) Movable airscrew head for variable and collective pitch (outer starboard). (18) Air inlet to compressor. (19) Air compressor. (20) Combustion chambers. (21) First stage turbine driving air compressor. (22) Second stage turbine driving airscrew through hollow shaft. (23) Cone against which jet thrust reacts. (24) Jet tube and exhaust. (25) Outer aileron.

## KEY TO OTHER PARTS

(26) Elevators. (27) Rudder. (28) All controls enter central section of main spar. (29) Passenger-cabin with rearward facing seats. (30) Entrance door and vestibule. (31) Galley. (32) Radar and Radio Operator; Navigator on port side. (33) Control ducts. (34) Captain and Co-pilot. (35) Front pressure-bulkhead. (36) Retractable telescopic hydraulic support leg in nose. (37) Nose mooring lug to fit ground mooring structure. The telescopic support leg would be extended in emergency, for a three-point landing. (38) Port movable wing, identical to the starboard one.

## NEAR-VERTICAL TAKE-OFF IN NATURE

Compared with the long runways required by aircraft, birds are airborne by flapping their wings. Here a gannet is taking off almost vertically, with tail up (elevator in aircraft) and feet about to be drawn up to body (retractable undercarriage in aircraft).





# A RESCUE SYSTEM —FOR SUBMARINES

THE history of a submarine which the American navy knows as the most advanced vessel of its kind begins with a tragic loss. When the nuclear submarine *Thresher* perished in more than 8,400 ft. of water in April, 1963, the disaster emphasised the shortcomings of America's rescue craft, for no vessel could submerge deeply enough to go to *Thresher's* assistance.

Because the *Thresher* went down in water much deeper than its collapse depth, the rescue of its crew was impossible. However, all modern submarines can operate at depths below the limits of the present rescue system, the McCann Chamber, originally designed for submarines of

take them either to a "mother sub." or to a ship waiting on the surface.

Named the D.R.S.V.—Deep Submergence Rescue Vehicle—this powerful, extra-strong submarine can go as deep as 5,000 ft.

Within the outer shell are three pressure hull spheres, each having a diameter of 7½ ft.

The linking hatch, through which the submariners enter the D.R.S.V., is a bell-shaped device outside the torpedo-shaped outer hull.

## Advanced design!

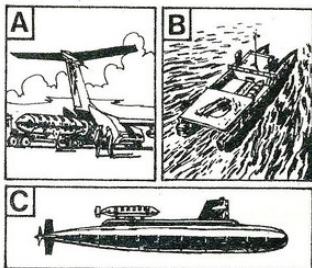
With the D.S.R.V., the U.S. Navy has a rescue craft which it can use anywhere in the world, even in the worst of weather, and which can go as deeply as today's most advanced submarines. Its ability to rescue 24 men at a time means that the rescuing and diving time is almost half of that originally considered necessary by the group of experts which drew up the first designs.

This D.S.R.V.-1 is 49 ft. 8 in. long and weighs some 76,000 pounds submerged. Its outer hull is made of fibre-glass reinforced plastic and contains the three-sphere inner hull (already described), and the vehicle's propulsion system and its various other devices. The forward sphere of the inner hull houses two operators who guide the vessel. The two other spheres hold the survivors and a third operator.

Eight different types of sonar (devices for navigating underwater), an optical viewing system and a television screen linked to a camera directed outside the vessel, enable the operators to "see" in the dark water far below the surface of the ocean.

Although most rescue trips are expected to last about three hours, the D.S.R.V. can cruise for eight hours at a maximum speed of 4½ knots.

Following its launching earlier this year, the D.S.R.V.-1 is undergoing a series of tests at a dockside and at sea. These will ensure that it is thoroughly reliable before it goes into service with the American navy.



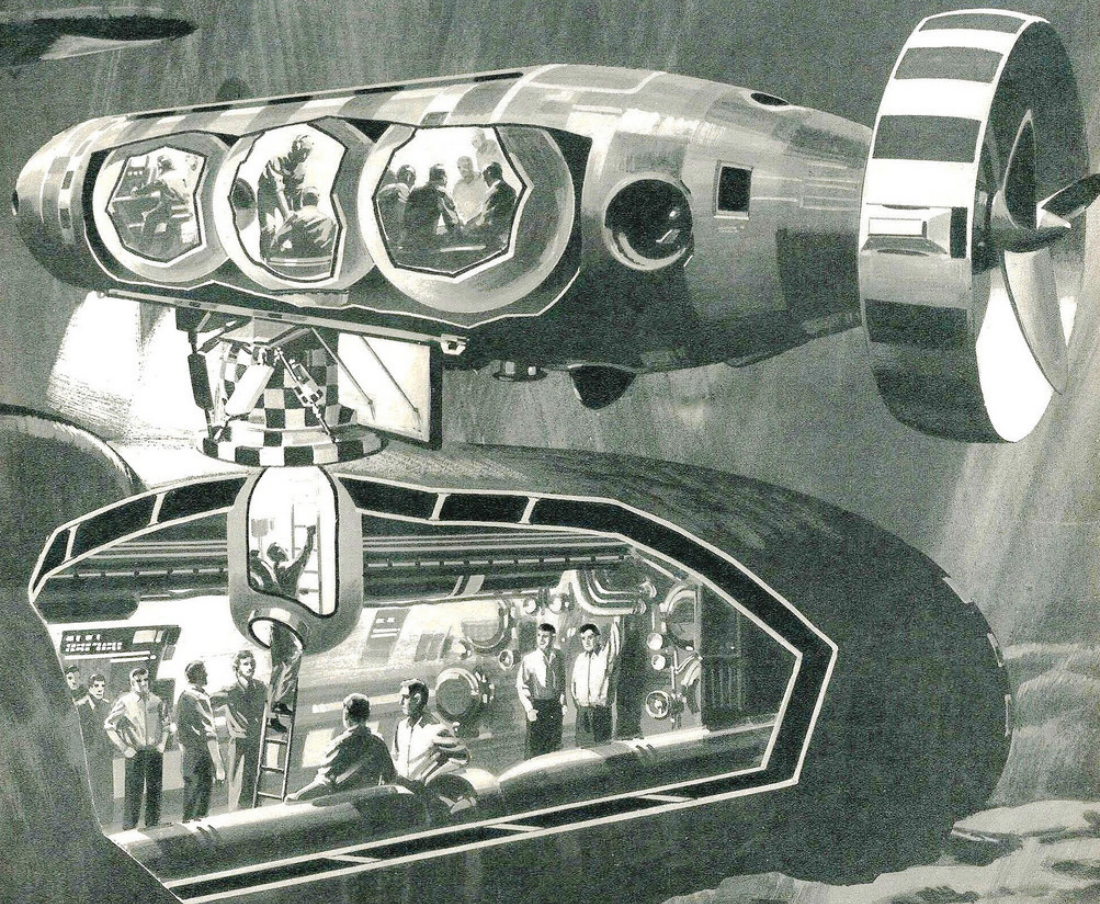
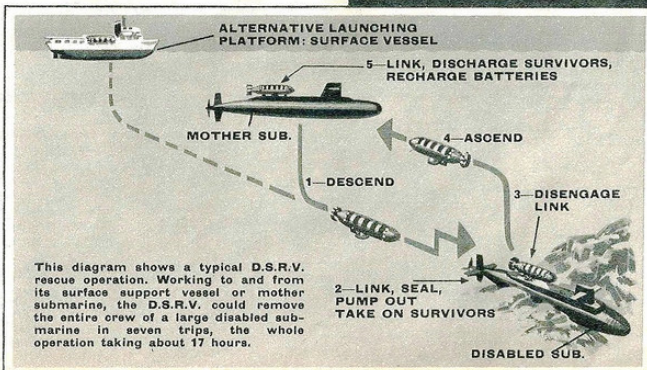
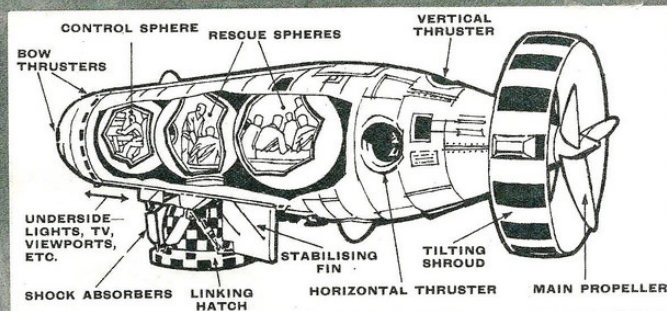
The D.S.R.V. is designed to be flown rapidly to any part of the world in a Lockheed C-141A Starlifter jet transport (A). The jet will deliver it to the airfield nearest to a suitable port. From there, it will go to sea on its surface support vessel (B) or its special "mother sub" (C) on which it rides "piggy back."

the 1920s. One of its main drawbacks is its need for surface support, which means that bad weather can cancel any rescue attempt and operations under ice are impossible.

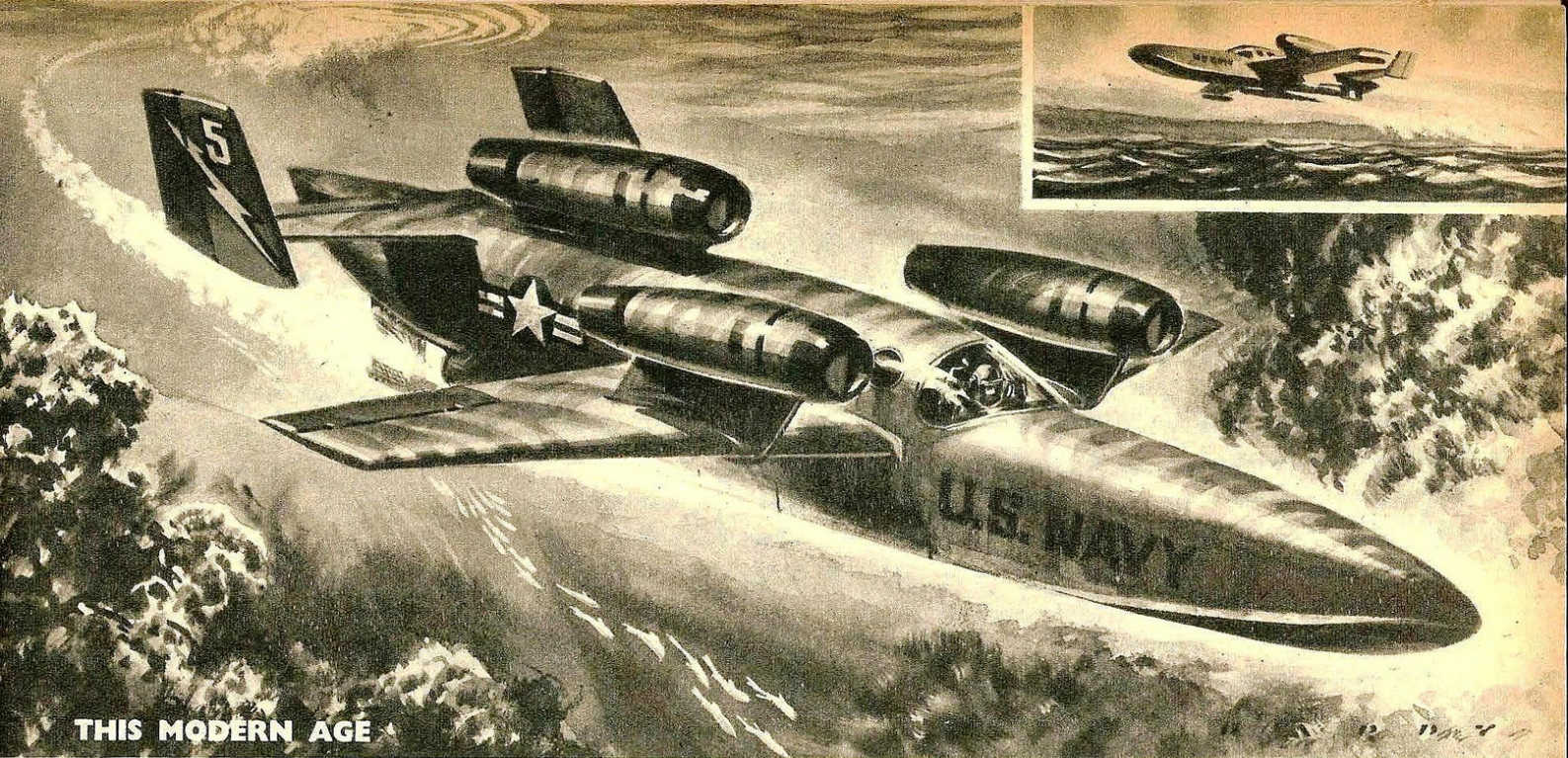
Following the *Thresher* tragedy, the U.S. Navy formed a group of experts to develop a better rescue system. After careful study, these people decided that a highly manoeuvrable vessel that could be used submerged was needed because it would free the rescue system from the limitations of ice, weather and depth.

The result was the formation of the Deep Submergence Systems Project and its first job was to make a rescue vehicle which could be used at great depths. The U.S. Navy wanted a vessel which could rescue up to 12 submariners at a time, be light enough to be flown by air to the disaster area and have a spherical pressure hull. It was to be made of steel stronger than that ever used before for a submarine.

Many designs were considered and the one finally chosen was for a vessel large enough to rescue up to 24 men at a time from a stricken submarine. The pictures on these pages show you what the rescue vessel looks like and how it is operated. You can see that when the rescue craft is in place over the damaged submarine, a linking hatch is clamped in position over the submarine escape hatch. The submariners climb through the hatch to the rescue vessel, which







## THIS MODERN AGE

With its jet engines sealed, the Sub-Plane cruises under water. Inset above: A sea take-off using a retractable hydro-ski.

# A FLYING SUBMARINE

**This air-to-underwater craft is now being built**

**W**HEN man first designed a submarine, critics said that that kind of craft belonged very much to the future. They said the same when the aeroplane was first designed. And until recently the suggestion that a craft which combined the qualities of both could be built successfully would have met with the same objection.

But suddenly the future comes very close, for after a six-months study American experts decided that such a craft is feasible and practical. What is more, plans have been prepared, and though most of the details are secret, some information has been released.

The Sub-Plane, as they call it, will look something like a flying boat, with three turbo-jet engines mounted on the wings and rear fuselage, the latter for cruising and the former for take-off assistance. There will be a hydro-ski of the type used on hydrofoil craft already in use, capable of being retracted.

Nothing unusual there, so far as air flight is concerned, but what happens when the journey continues under the sea?

Naturally the jet engines will have to be sealed so that they become completely watertight, and "controlled sinking" will be achieved by flooding tanks as in ordinary submarine practice.

Underwater propulsion will be by a battery-driven electric motor operating a shrouded propeller at the

bottom of the fuselage, and it is estimated that the ordinary flight controls will enable the Sub-Plane to be steered under water.

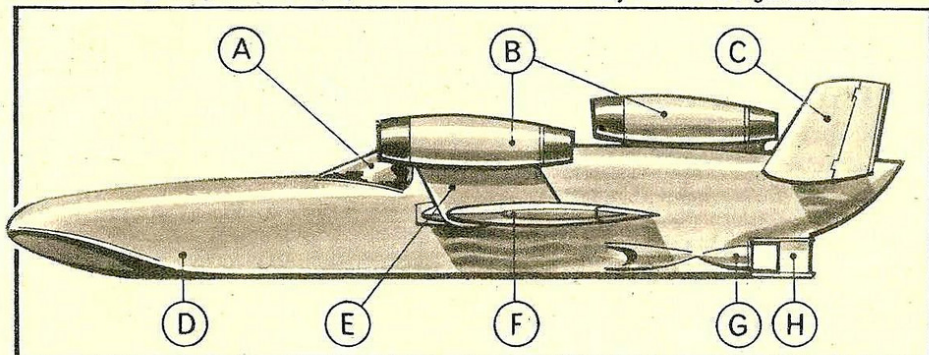
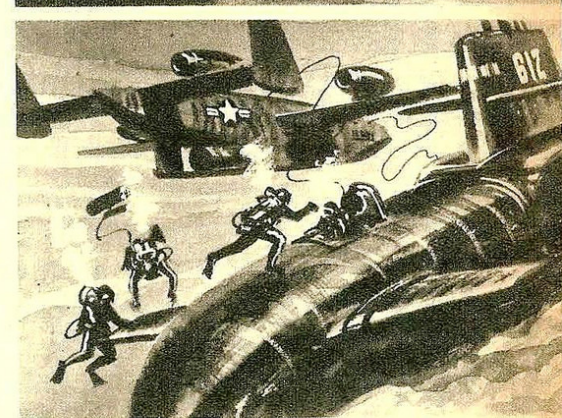
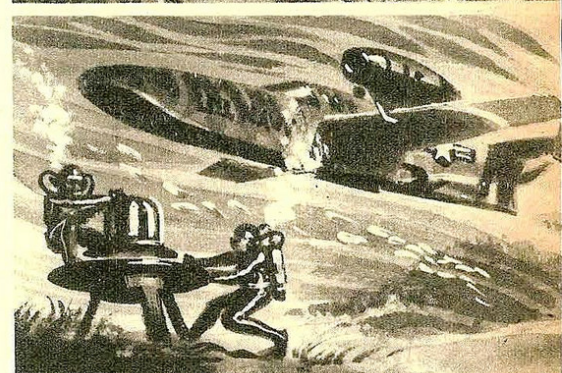
The emphasis of the whole project is, of course, that this would be a useful weapon of war; that is why full details are lacking. No doubt a beginning would be made with a small craft, but larger ones could develop from it.

Initial speeds, as announced, are that the Sub-Plane will fly at up to 500 miles an hour, but one can well imagine that this will soon be exceeded.

One problem is to provide escape gear in case of trouble, suitable for use either in the air or under the sea, and the news is that the designers have solved this problem.

The whole project is to be developed by the Convair organization in collaboration with the Electric Boat Division of the General Dynamics company.

On the right illustrations show three possible developments of the Sub-Plane. At top, for secret landings and commando attack operations. Centre: Underwater beacons might be installed for navigational purposes. At bottom: Underwater repair and rescue of submarines would be an important part of any Sub-Plane organization.



## MAIN FEATURES OF THE SUB-PLANE

A, Control cockpit and cabin space. B, Jet engines for flight power. C, Tail assembly with elevator and rudder flying controls. D, Streamlined flying-boat type hull with retractable hydro-ski for water take-off and surface cruising. E, Jet engine pylons. F, Wing with aileron flying control. G, Shrouded underwater propeller. H, Underwater rudder.





THIS drawing slices away part of an imaginary shore line and shows some of the activities which are in a research stage. Only a few are in actual use, like the underwater house (1) in which men can live breathing air for long periods. An "ocean-auf" (underwater worker) is entering the "front door".

An underwater "bus" (2) takes men to work. Some would go each day to the "hives" called Biotrons (3) in which young fish collect in search of rich food placed there by divers. There the fish would multiply and grow until they were large enough to be pumped through pipes into cages (4).

Here they would feed on natural and synthetic food and grow to edible size before being sucked into tanks (5) ready for lifting to the surface by a gantry (6) and shipped to market.

Another way of containing fish (7) is a massive coral with "wai" made of air bubbles rising from perforated pipes on the seabed. Fish too large to keep in cages would be released to complete their growth in open water and then caught by submarine trawlers (8).

Lobsters and crabs could be bred in traps (9) on natural reefs. 10 represents a research laboratory with an aquarium for studying fish. Fish spawn could be collected and hatched out in vast quantities, then transplanted into the Biotrons.

A mobile seabed harvester (11) roams the seabed pasturing whales. Not propelled along by a powered unit (12) directs operations by radio. This could also be done with a deep sea research submarine (13).

If we are able to farm the sea, synthetic foods will have to be produced in great quantities. Solar mirrors reflecting the sun's rays on to inland saltwater reservoirs (14) assist the growth of such food. 15 is a "gravimeter" for detecting oil or minerals under the sea floor.

Some metals, such as manganese, collect on the seabed. Powerful magnets (16) would harvest great quantities of these mineral ores. Deposits of silt, rich in minerals, could be sucked up by huge "vacuum cleaners" (17) and pumped to the surface for refining. Underwater oil rigs (18) could extract crude oil and pump it to tankers above; or better still it may be possible to refine oil and minerals on the seabed (19). Only refined produce would then have to be transported.

In time to come much of this machinery may be driven by atomic power. Atomic reactors (20) could also produce respiratory gases for divers to breathe and at the same time heat the seabed water causing it to rise, carrying nutrient food with it, thus assisting fish and plankton growth near the surface.

Plankton harvesting ships (21) would roam these areas in search of big concentrations of this rich food—fodder for the fish farms.





LOOKING  
INTO  
SCIENCE



# TWIN-HULLED SEA WIZARD

**A** HUGE vessel which stays in one place without an anchor and scarcely heaves in the most turbulent of seas is now being used as a base for divers and repair experts.

Because its two hulls, seen clearly in the cut-away drawing on the right, are below the surface waves, the vessel—known as *Duplus*—rides the sea as smoothly as a submarine. Across the hulls is a broad, flat deck, the underside of which is above all but the most mountainous of waves.

The Dutch company which perfected this vessel have added many other assets. Among these is its ability to hold its position by means of propellers driven by electric motors and controlled by a computer. This notices the slightest movement and switches on the propeller needed to correct it. Hydrofoils link the hulls fore and aft and considerably reduce any tendency to heave and pitch, in addition to housing the positioning propellers.

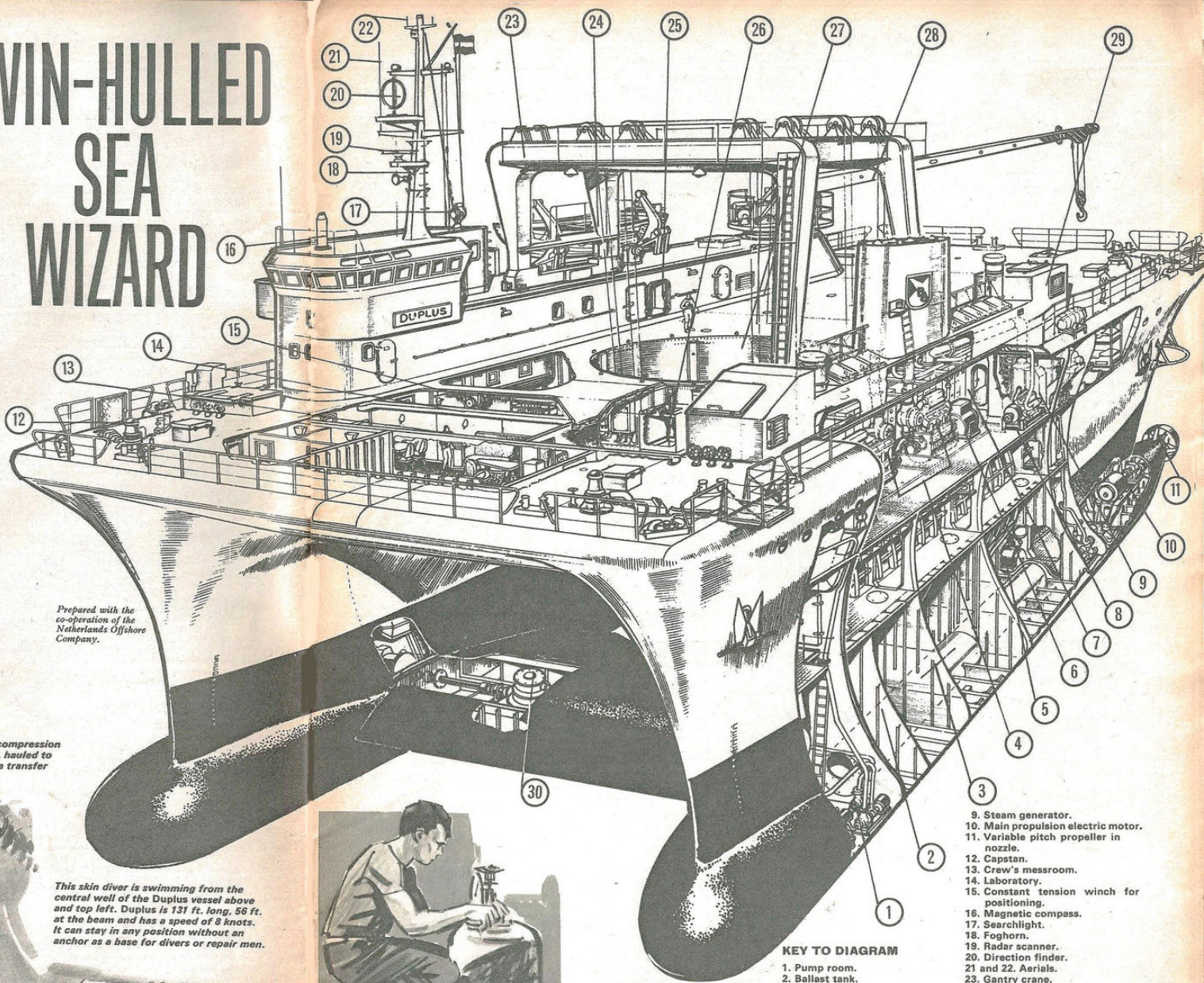
Oil and gas rigs can be fixed or repaired by divers working from *Duplus*. A central well 23 ft. across is large enough for a complete diving bell to be lowered into the sea. Skin divers operating from the vessel can lay underwater pipelines or repair damaged rigs or ships.

Electronic equipment is provided for sonar profiling—the mapping of the ocean bed by the use of sound waves. Samples of the sea bed can be taken with other apparatus.

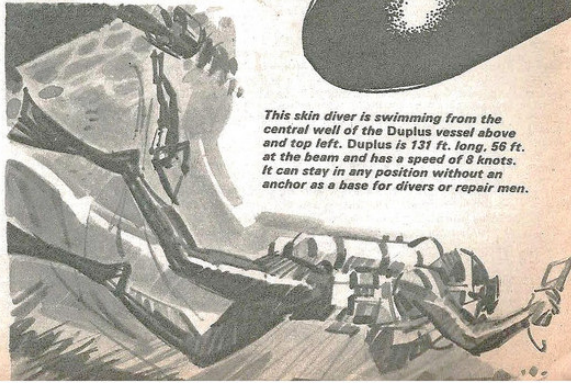
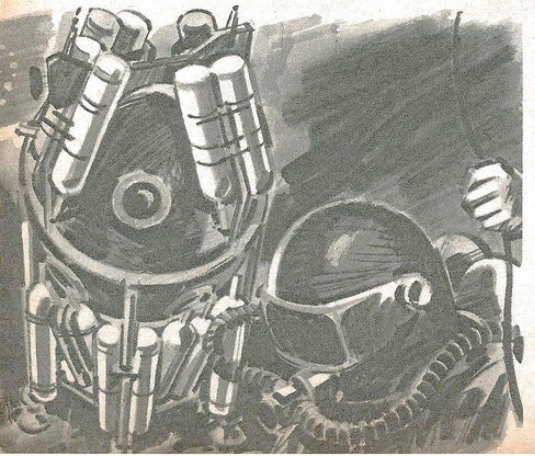
Divers returning from the sea depths must become accustomed in slow stages to the reduced pressure on the surface. A new compression chamber helps this to be done efficiently.

The diver is brought to the surface in the chamber, from which he has been operating at the end of a 65 ft. air line. The diving chamber is then attached to a transfer chamber in which the air pressure is slowly reduced to a safe level.

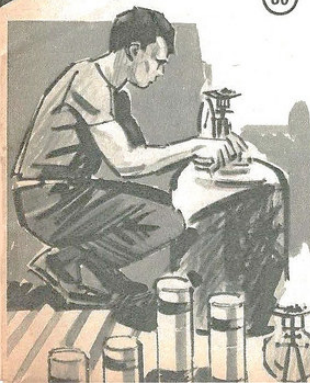
*Prepared with the co-operation of the Netherlands Offshore Company.*



*Left: A diver returns to his compression chamber. This will be sealed, hauled to the surface and attached to a transfer chamber for decompression.*



*This skin diver is swimming from the central well of the Duplus vessel above and top left. Duplus is 131 ft. long, 56 ft. at the beam and has a speed of 8 knots. It can stay in any position without an anchor as a base for divers or repair men.*



*On board Duplus is a small laboratory where samples from the sea-bed can be weighed and checked (left). The vessel is stable enough for this to be done in most weather conditions.*

## KEY TO DIAGRAM

1. Pump room.
2. Ballast tank.
3. Fuel oil tanks.
4. Main engines.
5. Electric motor for positioning propeller.
6. Main generator.
7. Switchboard.
8. Auxiliary diesel generator.
9. Steam generator.
10. Main propulsion electric motor.
11. Variable pitch propeller in nozzle.
12. Capstan.
13. Crew's messroom.
14. Laboratory.
15. Constant tension winch for positioning.
16. Magnetic compass.
17. Searchlight.
18. Foghorn.
19. Radar scanner.
20. Direction finder.
- 21 and 22. Aerials.
23. Gantry crane.
24. Lifeboat.
25. Diving centre.
26. Inclinerometer for positioning.
27. Central well.
28. Revolving crane.
29. Main winch.
30. Propeller.





**With only 122 pounds of uranium to provide the power, the world's first atomic ship sailed the equivalent of 15 times around the world**

The United States' "Savannah" represents the most revolutionary development in ocean transport since the birth of the steamship 164 years ago.

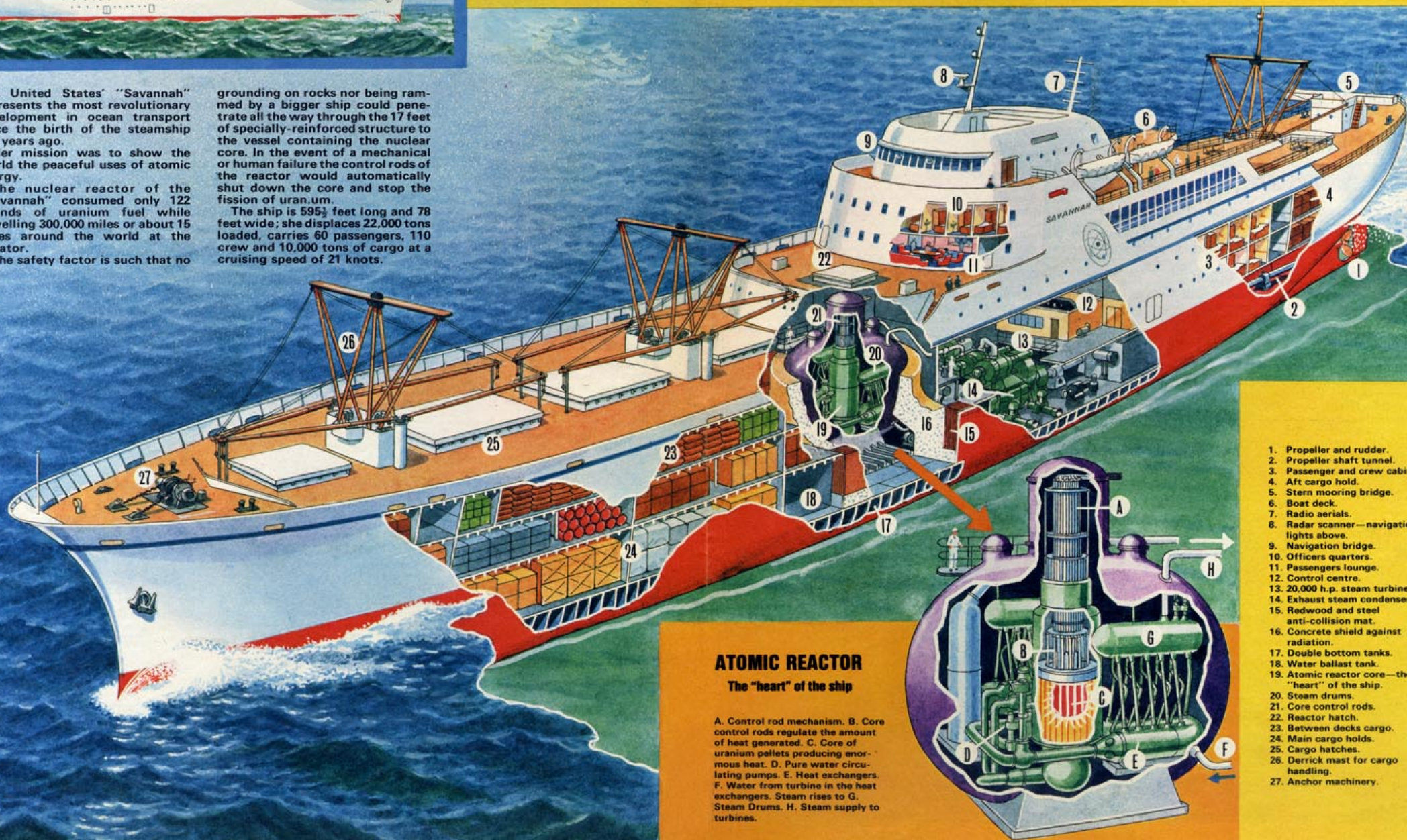
Her mission was to show the world the peaceful uses of atomic energy.

The nuclear reactor of the "Savannah" consumed only 122 pounds of uranium fuel while travelling 300,000 miles or about 15 times around the world at the equator.

The safety factor is such that no

grounding on rocks nor being rammed by a bigger ship could penetrate all the way through the 17 feet of specially-reinforced structure to the vessel containing the nuclear core. In the event of a mechanical or human failure the control rods of the reactor would automatically shut down the core and stop the fission of uranium.

The ship is 595½ feet long and 78 feet wide; she displaces 22,000 tons loaded, carries 60 passengers, 110 crew and 10,000 tons of cargo at a cruising speed of 21 knots.



## ATOMIC REACTOR

The "heart" of the ship

A. Control rod mechanism. B. Core control rods regulate the amount of heat generated. C. Core of uranium pellets producing enormous heat. D. Pure water circulating pumps. E. Heat exchangers. F. Water from turbine in the heat exchangers. Steam rises to G. Steam Drums. H. Steam supply to turbines.

1. Propeller and rudder.
2. Propeller shaft tunnel.
3. Passenger and crew cabin.
4. Aft cargo hold.
5. Stern mooring bridge.
6. Boat deck.
7. Radio aerials.
8. Radar scanner—navigation lights above.
9. Navigation bridge.
10. Officers quarters.
11. Passengers lounge.
12. Control centre.
13. 20,000 h.p. steam turbines.
14. Exhaust steam condensers.
15. Redwood and steel anti-collision mat.
16. Concrete shield against radiation.
17. Double bottom tanks.
18. Water ballast tank.
19. Atomic reactor core—the "heart" of the ship.
20. Steam drums.
21. Core control rods.
22. Reactor hatch.
23. Between decks cargo.
24. Main cargo holds.
25. Cargo hatches.
26. Derrick mast for cargo handling.
27. Anchor machinery.



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# LOOK AND LEARN

No. 976, 22nd NOVEMBER, 1980.

EVERY MONDAY, PRICE 35p.

## MALTA — An Island Fortress

SEE PAGE 2

## SUPERMAN OF THE SEABED

Read about an amazing underwater revolution — on page 6



A diver becomes an underwater giant when he is lowered by crane in the metal "suit" shown here, in order to repair or inspect an oceanic drilling rig or oil platform. Motor powered arms and claws give him the dexterity of a diver and the strength of a superman. While at work, the operator breathes air at atmospheric pressure. A cable links him with the "mother" ship on the surface. But if the cable fails the pilot can call upon emergency systems, which can keep him alive for up to 72 hours while the rescue services come to his aid.

Communications equipment, power supply, TV, data transmission

Oxygen supply

TV camera and spotlight

Arm and claw controls

Suction pad

Buoyancy tank

Foot pedals for control of propellers

Normal underwater missions will last for eight hours at an operating depth of up to 610 metres. The craft's height is 2.30 metres, its width is 1.22 metres and its displacement is 1,200 kilograms. The operator can vary the attitude 30° backwards and 45° nose down, from a vertical position. Inflatable bags are available to keep the craft buoyant on the surface.

Emergency battery for powering thruster

Pressure-resistant hull

Hydraulic control valves for suction feet and thrusters

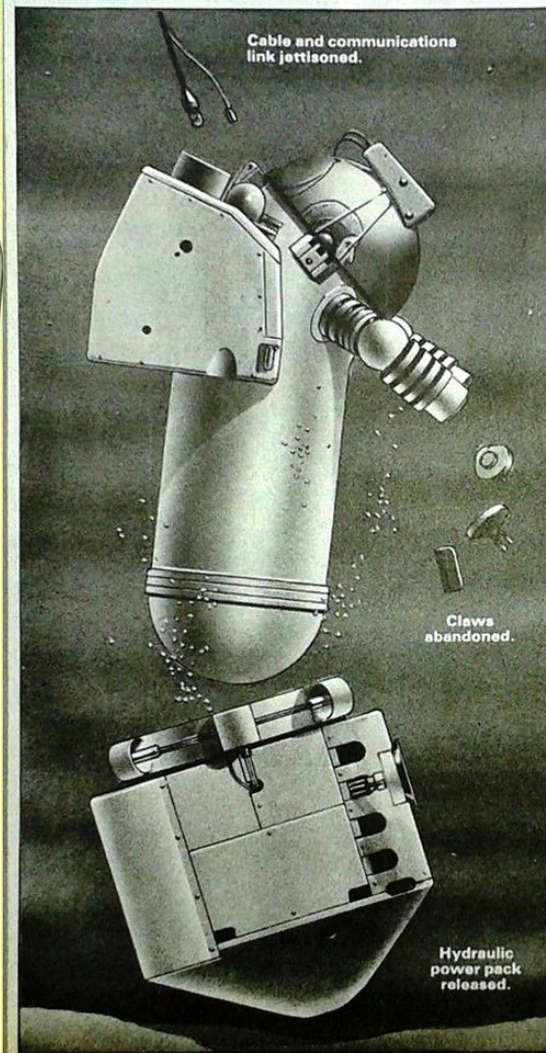
Reversible hydraulic motors

Cable and communications link jettisoned.

Claws abandoned.

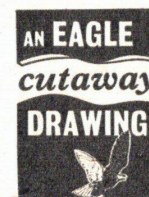
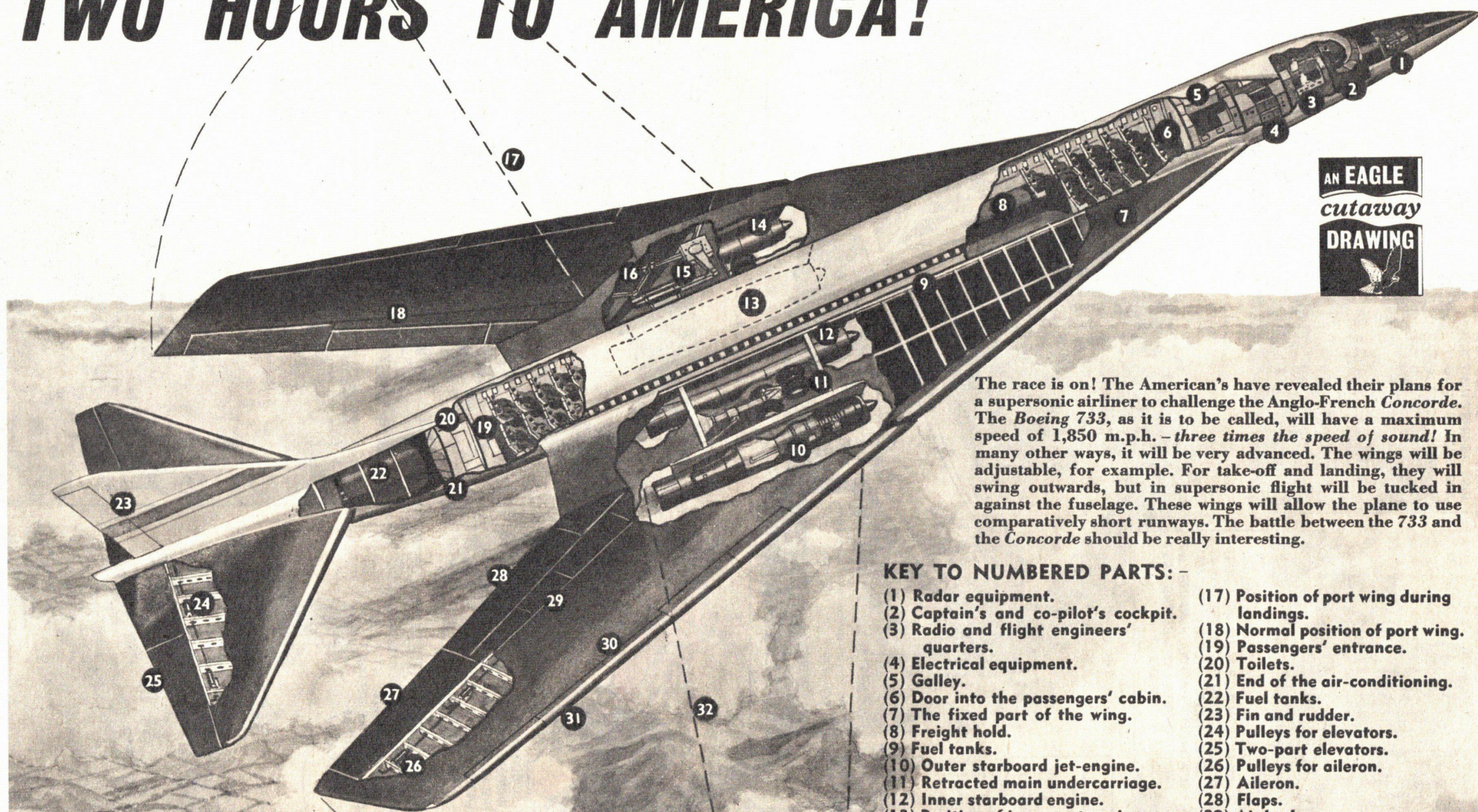
Hydraulic power pack released.

If an emergency makes a swift escape to the surface necessary, the diver can jettison many of his suit's accessories, such as the powered claws, communications cable and power pack. He is then able to rise because his suit has become sufficiently buoyant.





# TWO HOURS TO AMERICA!



The race is on! The American's have revealed their plans for a supersonic airliner to challenge the Anglo-French *Concorde*. The *Boeing 733*, as it is to be called, will have a maximum speed of 1,850 m.p.h. — *three times the speed of sound!* In many other ways, it will be very advanced. The wings will be adjustable, for example. For take-off and landing, they will swing outwards, but in supersonic flight will be tucked in against the fuselage. These wings will allow the plane to use comparatively short runways. The battle between the 733 and the *Concorde* should be really interesting.

## KEY TO NUMBERED PARTS: —

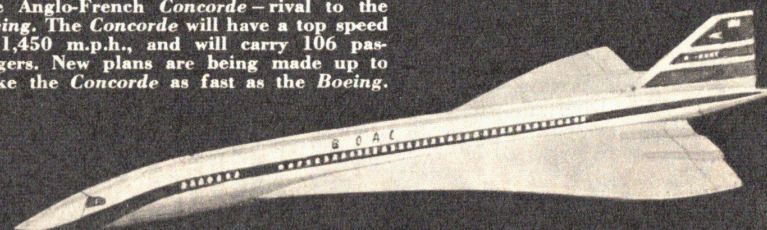
- |                                           |                                             |
|-------------------------------------------|---------------------------------------------|
| (1) Radar equipment.                      | (17) Position of port wing during landings. |
| (2) Captain's and co-pilot's cockpit.     | (18) Normal position of port wing.          |
| (3) Radio and flight engineers' quarters. | (19) Passengers' entrance.                  |
| (4) Electrical equipment.                 | (20) Toilets.                               |
| (5) Galley.                               | (21) End of the air-conditioning.           |
| (6) Door into the passengers' cabin.      | (22) Fuel tanks.                            |
| (7) The fixed part of the wing.           | (23) Fin and rudder.                        |
| (8) Freight hold.                         | (24) Pulleys for elevators.                 |
| (9) Fuel tanks.                           | (25) Two-part elevators.                    |
| (10) Outer starboard jet-engine.          | (26) Pulleys for aileron.                   |
| (11) Retracted main undercarriage.        | (27) Aileron.                               |
| (12) Inner starboard engine.              | (28) Flaps.                                 |
| (13) Position of inner port engine.       | (29) Air brakes.                            |
| (14) Outer port engine.                   | (30) Anti-stalling leading edge slots.      |
| (15) Pulleys for the adjustable wing.     | (31) Starboard wing in flying position.     |
| (16) Control box for the ailerons, etc.   | (32) And in landing position.               |

L. ASHWELL  
L. WOOD

The American *Boeing 733*. The *Boeing* is to have a top speed of 1,850 m.p.h., and will have a passenger capacity of 150 to 227.



The Anglo-French *Concorde* — rival to the *Boeing*. The *Concorde* will have a top speed of 1,450 m.p.h., and will carry 106 passengers. New plans are being made up to make the *Concorde* as fast as the *Boeing*.





# WORLD'S BIGGEST JET-AIRLINER

**T**ODAY, there are about 800 big jets in long-distance service with some 50 commercial airlines in the world, and these aircraft have changed man's idea of distance. Now the biggest of them all, the 490-seater Boeing 747, is being built and will first fly in 1968. Pan American Airlines have ordered 25 of these monsters at a cost of roughly £7½ million each. In this country, B.O.A.C. are also interested.

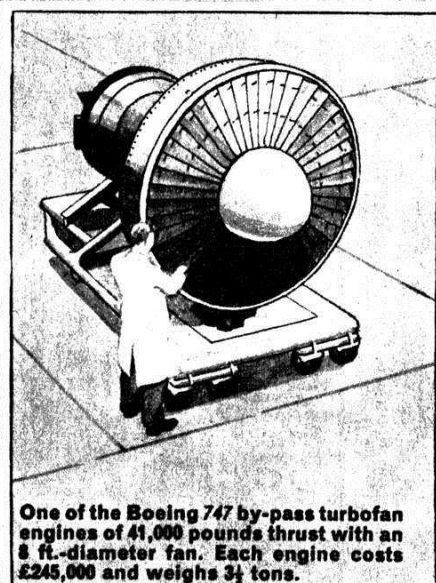
With a loaded weight of over 300 tons, the 747 will have a cruising speed of 635 m.p.h. at 45,000 ft., flying higher than airliners do today. It will have a range of 5,800 miles with full 490-passenger load and 5,000 pounds of mail and cargo. A special feature is the huge main passenger compartment, 19 ft. 7 ins. wide, stretching from nose to tail. At the forward end, there is a second deck with flight crew compartment and first-class passenger staterooms.

This enormous aircraft will be powered by four Pratt and Whitney by-pass turbofan jet engines of 41,000 pounds thrust each, mounted in pods below the wings.

An all-cargo version of the Boeing 747 will have an upward-swinging nose door for loading, similar to the military Lockheed C-5A, published in *EAGLE* on 2nd April this year. Boeing 747 dimensions are: - Length, 228 ft. 6 ins.; span, 195 ft.; height 62 ft. 7 ins.



How it all started 25 years ago. Britain's first jet aircraft, the Gloster-Whittle E28/39, compared to scale with the Boeing 747. Engine thrust 850 pounds.



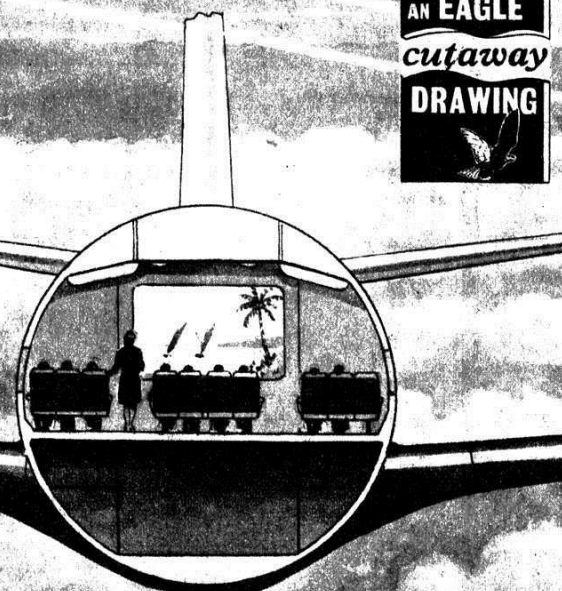
One of the Boeing 747 by-pass turbofan engines of 41,000 pounds thrust with an 8 ft.-diameter fan. Each engine costs £245,000 and weighs 3½ tons.

## KEY TO NUMBERED PARTS

(1) Flight deck. Captain, Co-pilot, Flight engineer, Navigator and Radio Operator. (2) Nose cabin. (3) Nose wheels - retracted. (4) One of four passenger doors forward. (5) First-class staterooms on second deck. (6) Toilets and galley. (7) Loading doors for special cargo containers. (8) Forward cargo hold. (9) Centre section fuel tank. (10) Electric anti-icing leading edge. (11) Inner port Pratt and Whitney by-pass turbofan jet engine. (12) Turbofan of outer port engine. (13) Two spool compressors. (14) Combustion chambers and turbine wheel casing. (15) Wing fuel tanks. Total capacity of all tanks, 48,000 gallons. (16) Leading edge flaps used for landing. (17) Port

aileron. (18) Wing spoilers; when raised these act as an additional roll control with the ailerons. (19) Double slotted flaps, used for take-off and landing. (20) Air brakes (lowered). (21) Four bogies abreast main undercarriage (retracted). (22) Ten abreast seating of the main tourist class compartment. (23) Wing spoilers, raised. (24) Flying control runs and cabin air conditioning equipment. (25) Rear cargo doors. (26) Galley. (27) Toilets. (28) Electric anti-icing to fin leading edge. (29) End of pressurized passenger compartment. (30) Tail plane pivot. (31) Rudder and elevator flying controls. (32) Rudder with trim tabs. (33) Elevators with trim tabs.

Cross-section of the huge 19 ft. 7 ins.-wide fuselage, showing the ten-abreast tourist seating and a back projection cinema screen, which will be a feature of entertainment in flight.



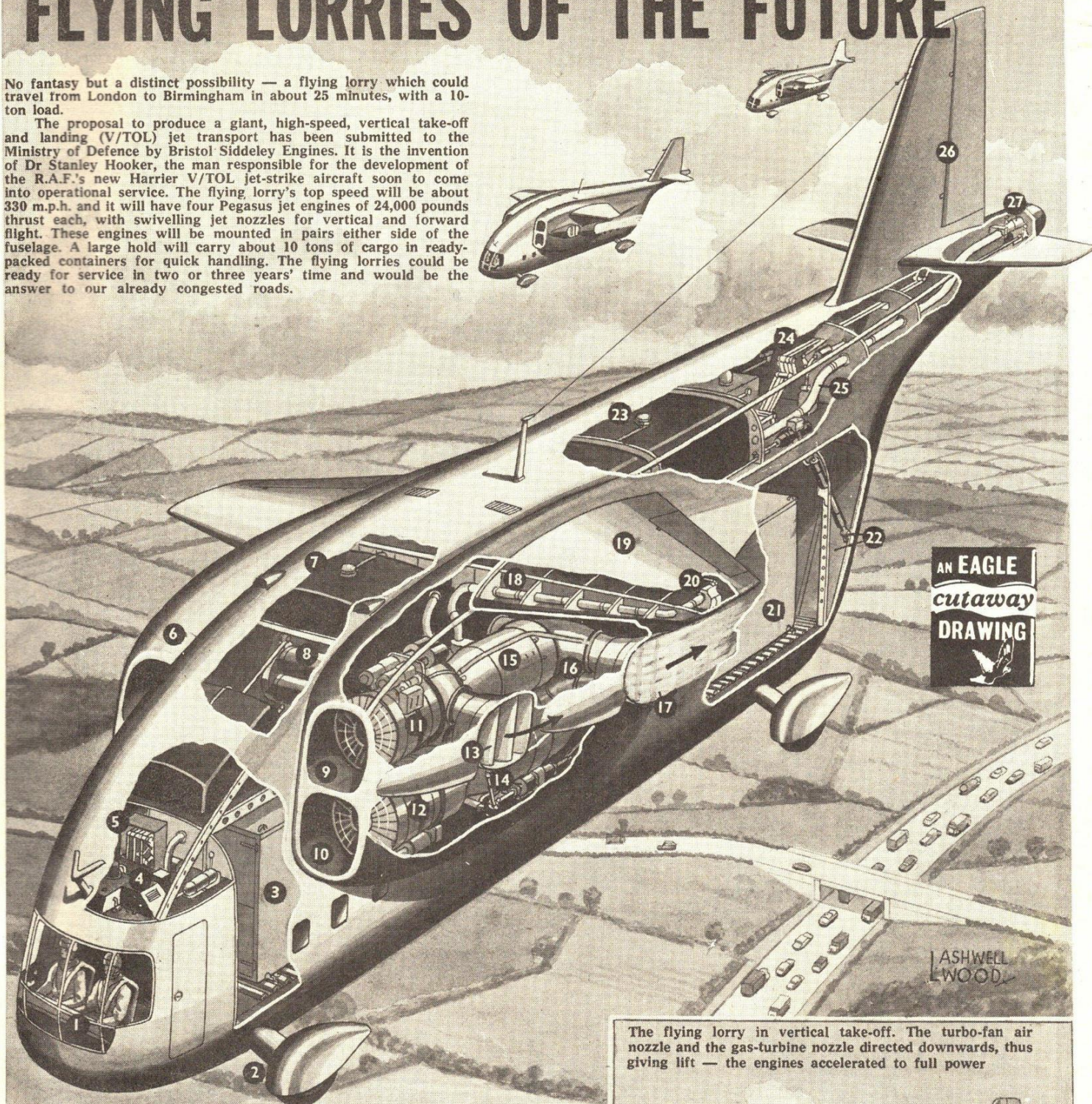
AN EAGLE  
cutaway  
DRAWING



# FLYING LORRIES OF THE FUTURE

No fantasy but a distinct possibility — a flying lorry which could travel from London to Birmingham in about 25 minutes, with a 10-ton load.

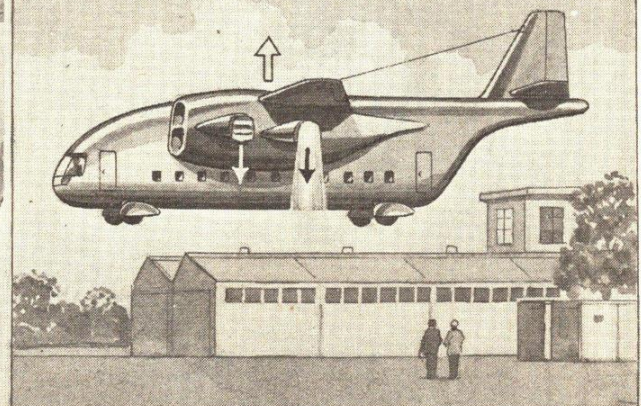
The proposal to produce a giant, high-speed, vertical take-off and landing (V/TOL) jet transport has been submitted to the Ministry of Defence by Bristol Siddeley Engines. It is the invention of Dr Stanley Hooker, the man responsible for the development of the R.A.F.'s new Harrier V/TOL jet-strike aircraft soon to come into operational service. The flying lorry's top speed will be about 330 m.p.h. and it will have four Pegasus jet engines of 24,000 pounds thrust each, with swivelling jet nozzles for vertical and forward flight. These engines will be mounted in pairs either side of the fuselage. A large hold will carry about 10 tons of cargo in ready-packed containers for quick handling. The flying lorries could be ready for service in two or three years' time and would be the answer to our already congested roads.



AN EAGLE  
cutaway  
DRAWING

- (1) Pilot and co-pilot with forward and downward view. (2) Fixed undercarriage. (3) Container in cargo hold. (4) Radio and electronics. (5) Flying and engine controls. (6) Starboard twin engine nacelle. (7) Fuel tanks. (8) Exhaust nozzles are cross-ducted in case of one engine failure. (9) Air inlet to upper port engine. (10) Air inlet to lower port engine. (11-12) Turbo-fan section of Bristol Pegasus engines. (13) Turbo-fan air exhaust nozzle directed fully aft for forward flight. (14) Swivelling nozzle control. (15) Combustion chambers and turbine wheels of the gas-turbine section. (16) Jet outlet to exhaust nozzle. (17) Gas turbine exhaust nozzle directed fully aft for forward flight. Both engines are connected to these swivelling nozzles. For vertical take-off they are directed downwards and gradually directed aft for forward flight. (18) Air pipe from engine to roll control jet. (19) Stub wings giving stability in forward flight. (20) Air jet unit in wing tips for controlling roll of aircraft. (21) Container in cargo hold. (22) Cargo door and operating jack. (23) Fuel tank. (24) Flying controls. (25) Air pipe from engine to tail pitch control. (26) Fin and rudder. (27) Air jet unit for tail pitch control.

The flying lorry in vertical take-off. The turbo-fan air nozzle and the gas-turbine nozzle directed downwards, thus giving lift — the engines accelerated to full power



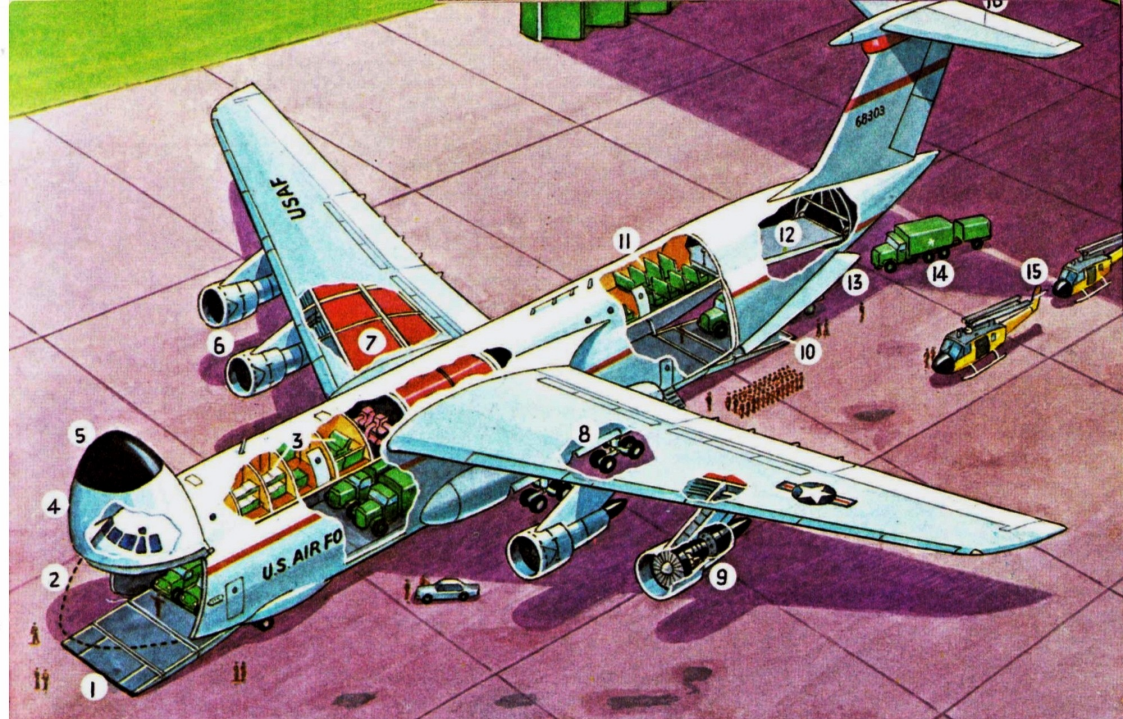


# BIGGEST PLANE EVER BUILT

SO huge is this super-transport, shown opposite, that its controls have to be operated by computers. Its tail is as high as a six-storey building. This is the Lockheed C-5A Galaxy of America. With a loaded weight of 350 tons it is hard to conceive how it gets off the ground. The power is provided by four giant General Electric CTF turbofan engines, suspended in pods beneath the wings. The huge interior can accommodate tanks, helicopters, trucks and 75 troops, or it can be converted to carry 840 troops to any trouble spot in the world. The Galaxy cruises at 541 miles an hour and has the terrific range of 6,300 miles. Length 222 ft. 8 ins. Wing span 245 ft. 11 ins. The tail plane is 64 feet above the ground. The R.A.F. might use these aircraft.

## KEY TO NUMBERED PARTS

(1) Folding loading ramp lowered. (2) Position of nose when lowered. (3) Upper deck for flight crew, crew rest rooms and important person's lounge. (4) Nose cargo door raised. (5) Radar dome. (6) Starboard turbofan engines. (7) Wing fuel tanks, total tank capacity 42,000 gallons. (8) Main retractable under-carriage of 24 wheels 12 each side. (9) General Electric CTF turbofan engines, each of 41,000 pounds thrust. The intake fan is 8 feet in diameter. (10) Rear cargo ramp lowered. (11) Accommodation for 75 troops on rear upper deck. (12) Upward opening cargo door. (13) Fuselage petal doors open. (14) U.S. Army trucks being loaded. (15) Two 3½ ton Bell helicopters can be carried.



**LOCKHEED GALAXY**  
UNITED STATES AIR FORCE



# FLOATING SEA-PORT

**T**HE Royal Navy's first float-on, float-off assault ship, *H.M.S. Fearless*, is designed to carry anywhere in the world a complete military force – troops, tanks, scout cars, lorries and trucks, by means of landing craft carried in the ship's dock at the stern.

Troops will also be put ashore by landing craft carried in the ship's davits. *Wessex* helicopters will operate from a special deck over the flooding dock.

When the assault ship arrives offshore at any particular 'trouble spot', ballast tanks are flooded to lower the stern so that the landing craft can 'swim' in and out of the dock under their own power.

When the landing craft return the ballast tanks are pumped out and the dock is left dry. The craft are lashed in position, the stern door closed and the ship proceeds on her voyage.

The 12,100-ton ship is propelled by two separate sets of steam turbines driving separate propellers. Speed – 23 knots. Length – 520 ft. Beam – 80 ft. Crew consists of 36 officers and 490 ratings. *H.M.S. Fearless* can carry a fully-equipped Royal Marine commando, or an army infantry battalion of 900 men. She will act as an amphibious Command Headquarters with extensive radio communications to any part of the world. Equipment includes:

2 Mechanized landing craft in dock.

2 Assault landing craft in davits.

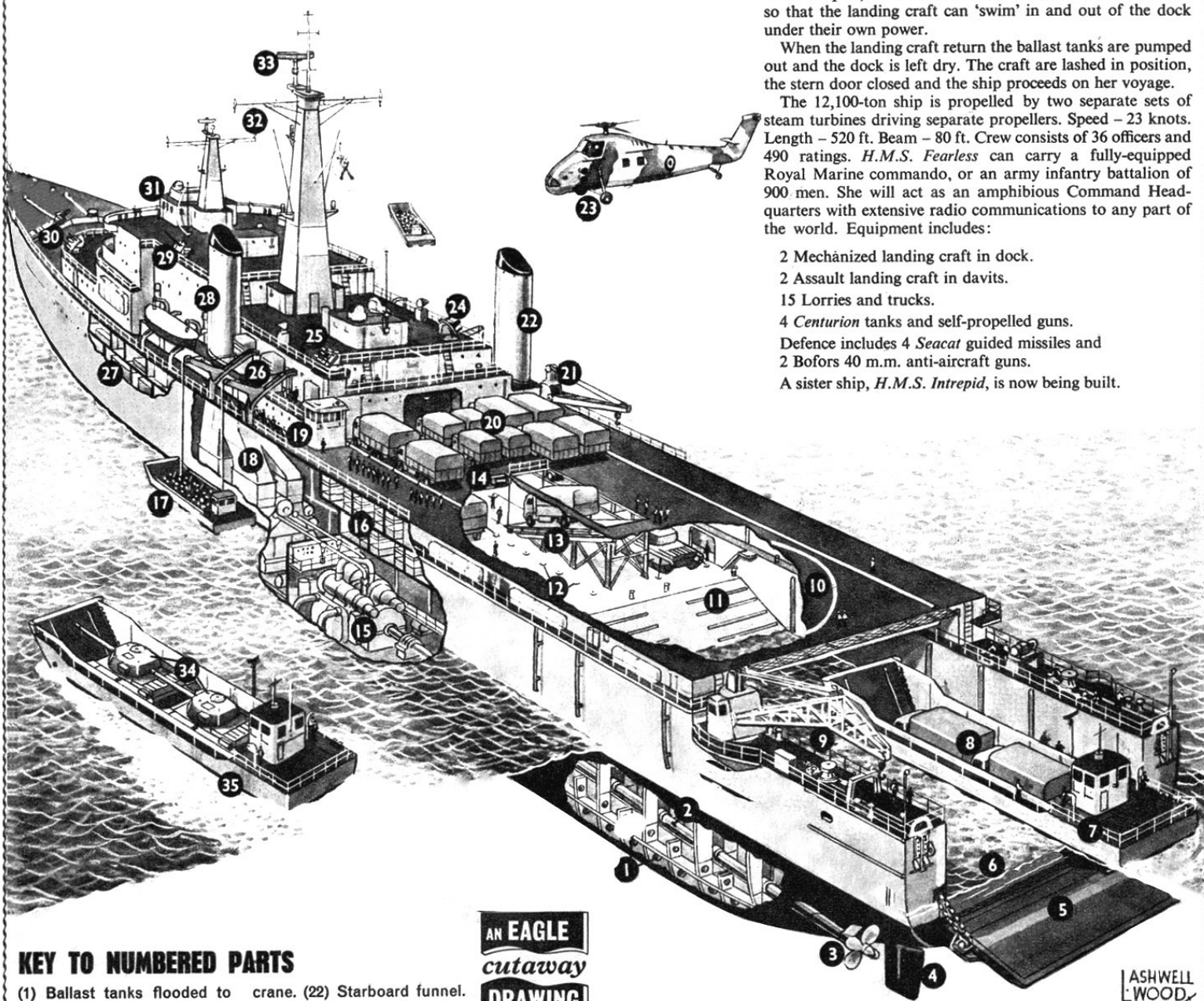
15 Lorries and trucks.

4 *Centurion* tanks and self-propelled guns.

Defence includes 4 *Seacat* guided missiles and

2 Bofors 40 m.m. anti-aircraft guns.

A sister ship, *H.M.S. Intrepid*, is now being built.



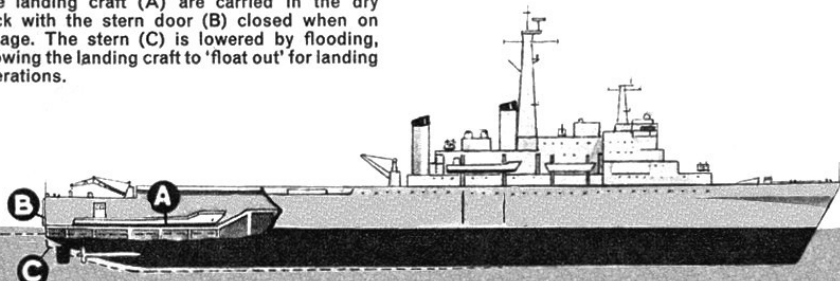
## KEY TO NUMBERED PARTS

(1) Ballast tanks flooded to lower ship's stern. (2) Port propeller shaft. (3) Port propeller. (4) Port rudder. (5) Dock stern door – lowered. (6) Water-level in flooded dock. (7) 176-ton mechanized landing craft – reversing out of dock. (8) Two 10-ton Army lorries. (9) Dock crane. (10) Helicopter deck. (11) Dock loading ramp. (12) Deck lashing points. (13) Hinged ramp between decks. (14) Electric winches for operating ramp. (15) Port – 12,000 h.p. steam turbines. (16) Assault troop quarters. (17) 14-ton assault landing craft. (18) Port boilers and uptakes. (19) Vehicle control post. (20) Vehicle stowage deck. (21) Deck crane. (22) Starboard funnel. The funnels are offset, the port funnel and boilers being more forward than the starboard. (23) *Wessex* commando helicopter. (24) *Seacat* guided missiles. (25) *Seacat* guided missiles. (26) Landing craft davits. (27) Crew's quarters and dining halls. (28) Port funnel. (29) 40 m.m. anti-aircraft gun. The decks below include officers' quarters – assault operations room – command head-quarters, etc. (30) *Seacat* guided missiles. (31) Navigation bridge. (32) Very extensive radio equipment. (33) Main radar scanner. (34) Two 51-ton *Centurion* tanks. (35) 176-ton landing craft.



## Heavy amphibious 'Assault Ship'

The landing craft (A) are carried in the dry dock with the stern door (B) closed when on voyage. The stern (C) is lowered by flooding, allowing the landing craft to 'float out' for landing operations.





# This 'Elephant' Has Wings

With a tail fin the height of a five-storey building, it is no surprise that the Boeing 747 aircraft is more popularly known as the Jumbo Jet — although even the largest of African elephants would be dwarfed by its huge bulk.

It can take up to 490 passengers and transport them over 10,000 kilometres in one non-stop flight. And while the passengers sit in air-conditioned comfort 10,000 metres up in the sky, an army of stewards and stewardesses attend to their needs. The only problem — equipping the airport terminals to cope with the simultaneous arrival of so many people!

DAN ESCOTT

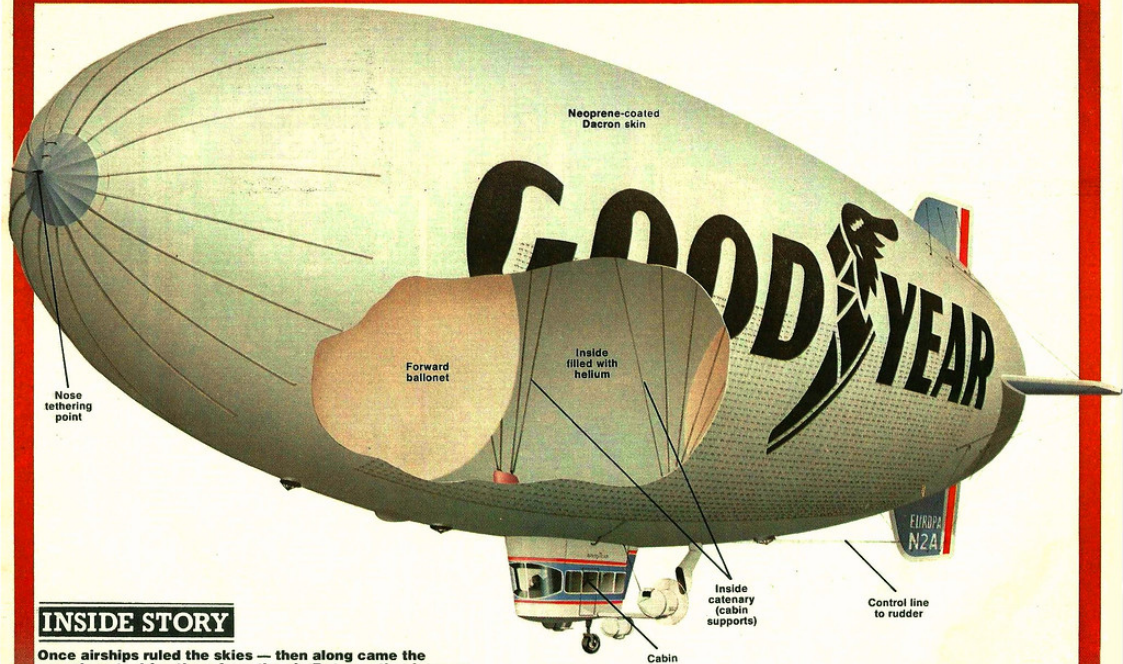


- A. Flight Deck
- B. Bars
- C. First Class Cabin
- D. Economy Class Saloons
- E. Landing Gear
- F. Galleys
- G. Rear Cargo Hold
- H. Toilets
- J. Wardrobes
- K. Air-Conditioning Ducts
- L. Weather Radar and Instrument Landing Systems
- M. VHF Antennae
- N. Lights

- 1. Air-conditioning Exchanger and Air-ducts
- 2. Turbine Gas Exhaust
- 3. Turbine Generators Supplying Electricity to Equipment On Board
- 4. Rear Cargo Hold
- 5. Centre Containerised Belly Hold
- 6. Main Landing Gear Bay
- 7. Air-conditioning Units
- 8. Forward Containerised Belly Hold

- 9. Nose-wheel Bay
- 10. Crew Entry Door
- 11. Crew Toilets
- 12. Air-conditioning Ducts
- 13. Recirculation Fan
- 14. Navigation Light
- 15. Drinking Water Tanks





## INSIDE STORY

Once airships ruled the skies — then along came the aeroplane to drive them from the air. But now that interest has been revived in these high-flying giants, could we soon be seeing...

# A New Airship Age?

Illustrated by Len Huxley

**A**N airship ride is still such a novel experience that anyone lucky enough to travel in one is sure to remember it for the rest of his life. In the future, however, airships could become so common that people will take them for granted much as we do supersonic jets.

There is nothing new about airships, of course. During the 20s and 30s, large, luxurious "zeppelins" effortlessly cruised across the Atlantic and back. But within three years, the bubble of optimism on which the ships had been riding burst. No less than three airships were destroyed in dreadful disasters, none worse than the spectacular end of the *Hindenburg*, which burst into flames while mooring at New York in 1937.

People's confidence in airships was badly shaken after this, and severe doubts began to be expressed about them.

Apart from their susceptibility to strong winds, the use of hydrogen in their envelopes brought a high fire risk. In any case, by the 30s the

development of aeroplanes was progressing rapidly.

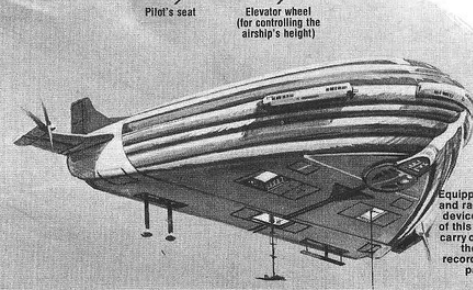
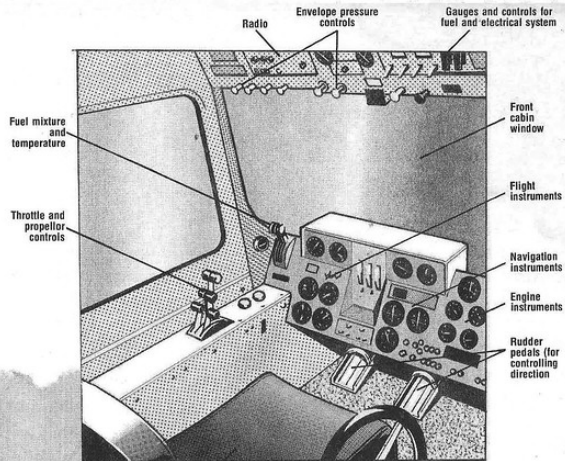
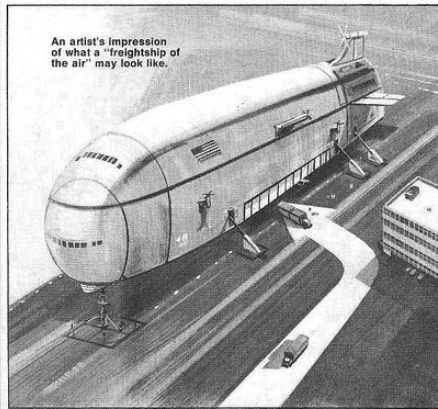
Soon there seemed nothing an airship could do which aeroplanes could not do better and faster. The airship seemed doomed to become the white elephant of a bygone era.

But today, the wheel of progress has turned full circle and airships are back in fashion. Non-inflammable gases and tough new materials have ensured that disasters like the *Hindenburg* will never happen again. Now, a rosy future is envisaged for these craft.

Uses they could be put to include heavy lifting, in areas where there are inadequate facilities for transporting heavy industrial equipment.

This would also render them attractive to the armed forces, who could use them for transporting tanks and cannon from ship to shore. And of course, with modern doctors deploring the mental and physical effects of high-speed travel, what could be more pleasant than a quiet, leisurely, lighter-than-air voyage?

An artist's impression of what a "freightship of the air" may look like.



Equipped with sonar and radar detection devices, an airship of this design could carry out a survey of the oceans and record the weather patterns which prevail there.

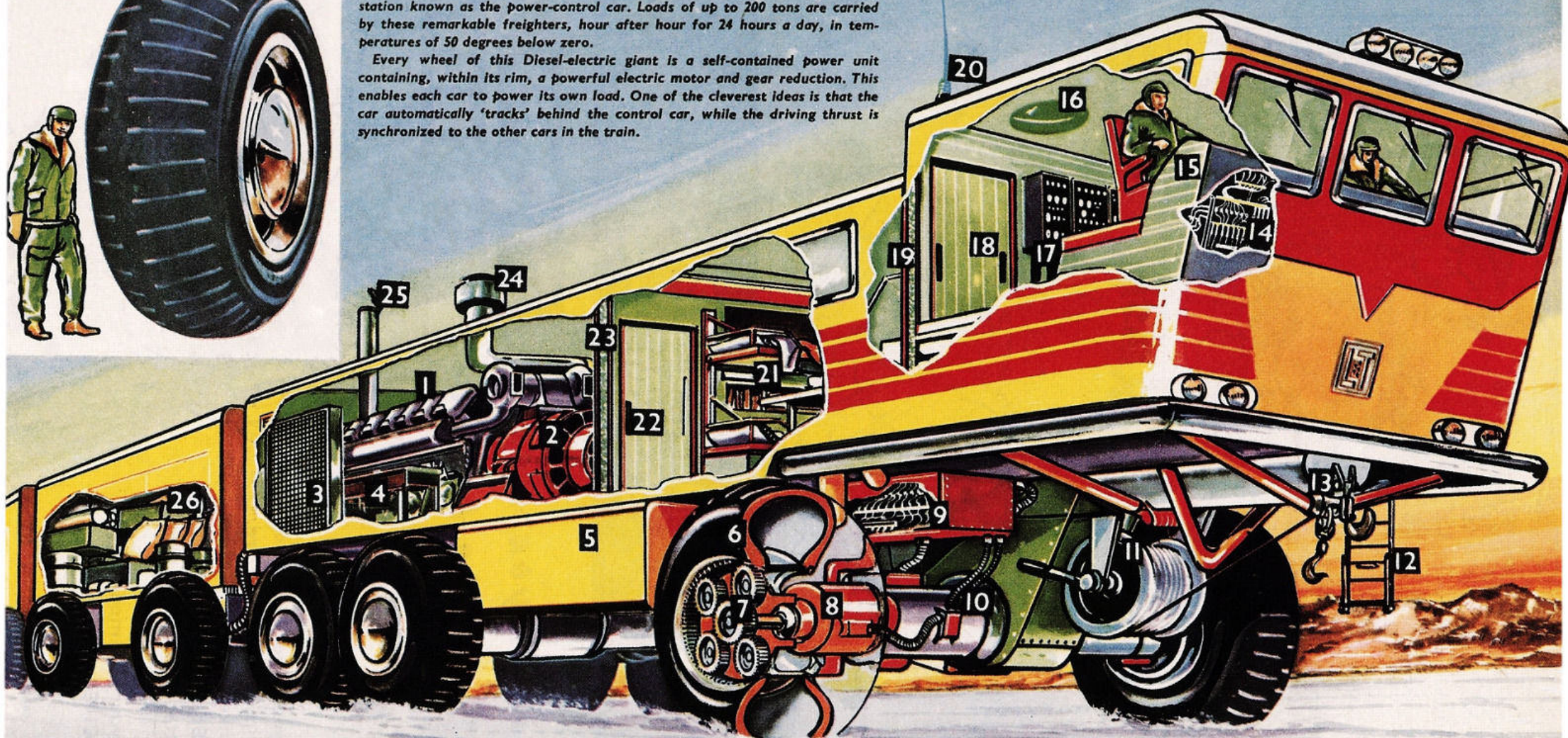


# Le TOURNEAU Cross-Country Freighter

This enormous vehicle is currently employed in the frozen wastes of Alaska, supplying food, stores and equipment to outposts such as the D.E.W. (Distant Early Warning) radar stations and other off-track installations.

Each car is self-propelled, and is powered and headed by a mobile generating station known as the power-control car. Loads of up to 200 tons are carried by these remarkable freighters, hour after hour for 24 hours a day, in temperatures of 50 degrees below zero.

Every wheel of this Diesel-electric giant is a self-contained power unit containing, within its rim, a powerful electric motor and gear reduction. This enables each car to power its own load. One of the cleverest ideas is that the car automatically 'tracks' behind the control car, while the driving thrust is synchronized to the other cars in the train.



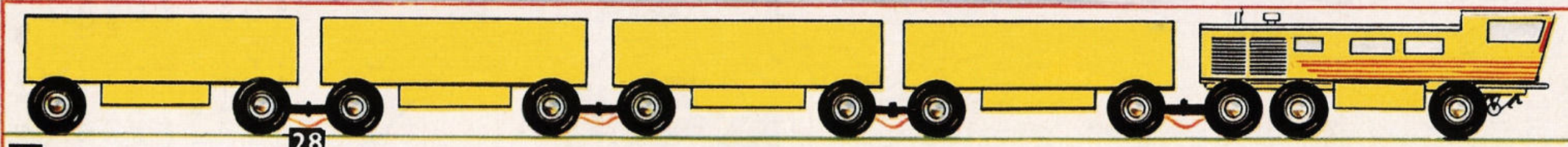
## KEY TO NUMBERED PARTS

(1) One of two powerful Diesel engines. (2) Generator supplying power to electric wheels. (3) Radiator. (4) Work bench. (5) Fuel tank. (6) Tubeless tyre, inflated at the low pressure of 5 lb. per sq. inch. (7) Internal gearing drive from

motor (8). The motor is supplied with power from the generator (2) and steers, as well as driving, the wheel. (9) Junction box and relay equipment. (10) Cable (armoured) mounted on heavy steel wheel-bearers. (11) Power winch. (12) Retractable ladder. (13) Various hooks, etc., for towing and hauling. (14) Instrument and switch wiring system.

(15) Control console. (16) Observation dome. (17) Instrument and control panels. (18) Sliding door. (19) Sound-proof insulation. (20) Whip aerial. (21) Luxurious living accommodation for two crews of 5 men each. (22) Sliding door to engine room. (23) Insulated walls. (24) Air intake to engine. (25) Exhaust pipe. (26) Stores, food and equipment in transit.

(27) This drawing shows you what a four-car train looks like - in some cases 5 and 6 cars can be used. The red lines between cars (28) are the power supply to each car. (29) This is only a two-car train to show you in greater detail the main power-control car. (30) This panel gives you some idea of the size of one of the 10-ft. electric wheels.





# FUTURE ATOMIC-POWERED AIRCRAFT CARRIER

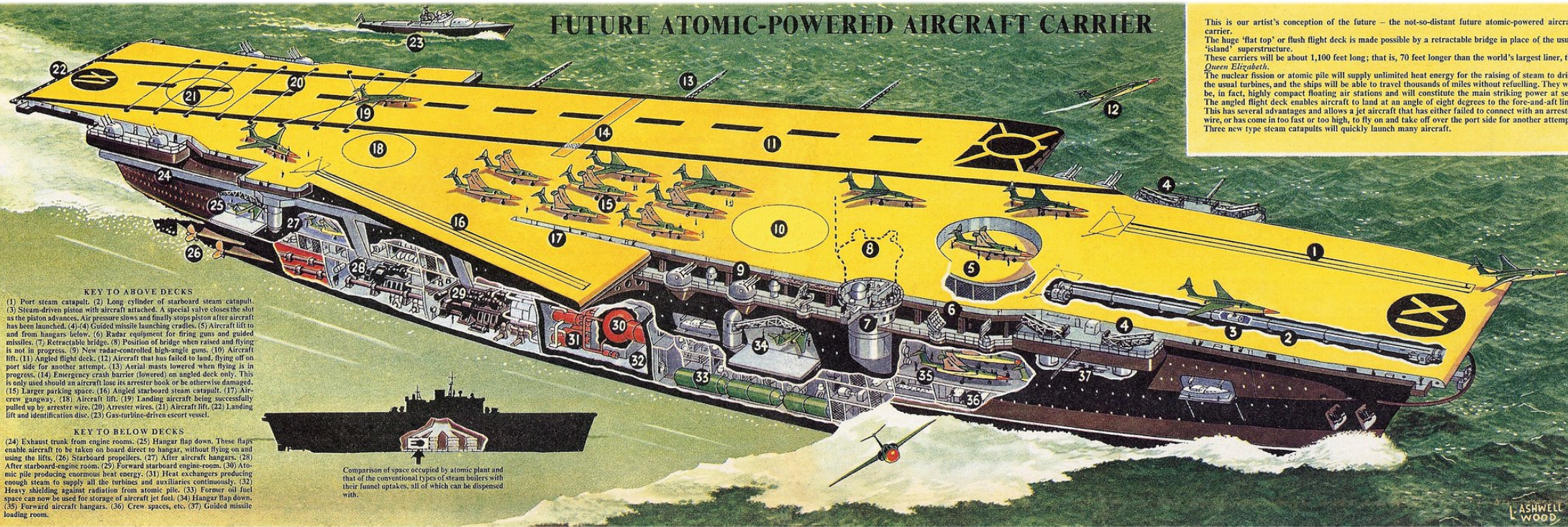
This is our artist's conception of the future — the not-so-distant future atomic-powered aircraft carrier.

The huge 'flat top' or flush flight deck is made possible by a retractable bridge in place of the usual 'island' superstructure.

These carriers will be about 1,100 feet long; that is, 70 feet longer than the world's largest liner, the *Queen Elizabeth*.

The nuclear fission or atomic pile will supply unlimited heat energy for the raising of steam to drive the usual turbines, and the ships will be able to travel thousands of miles without refuelling. They will be, in fact, highly compact floating air stations and will constitute the main striking power at sea.

The angled flight deck enables aircraft to land at an angle of eight degrees to the fore-and-aft line. This has several advantages and allows a jet aircraft that has either failed to connect with an arrestor wire, or has come in too fast or too high, to fly on and take off over the port side for another attempt. Three new type steam catapults will quickly launch many aircraft.



## KEY TO ABOVE DECKS

(1) Port steam catapult. (2) Long cylinder of starboard steam catapult. (3) Steam-driven piston with aircraft attached. A special valve closes the shot as the piston advances. Air pressure slows and finally stops piston after aircraft has been launched. (4) Guided missile launching cradles. (5) Aircraft lift to and from hangars below. (6) Radar equipment for firing guns and guided missiles. (7) Retractable bridge. (8) Position of bridge when raised and flying is not in progress. (9) New radar-controlled high-angle guns. (10) Aircraft lift. (11) Angled flight deck. (12) Aircraft that has failed to land, flying off on port side for another attempt. (13) Aerial masts lowered when flying is in progress. (14) Emergency crash barrier (lowered) on angled deck only. This is only used should an aircraft lose its arrestor hook or be otherwise damaged. (15) Larger parking space. (16) Angled starboard steam catapult. (17) Air-crew gangway. (18) Aircraft lift. (19) Landing aircraft being successfully pulled up by arrestor wire. (20) Arrestor wires. (21) Aircraft lift. (22) Landing lift and identification disc. (23) Gas-turbine-driven escort vessel.

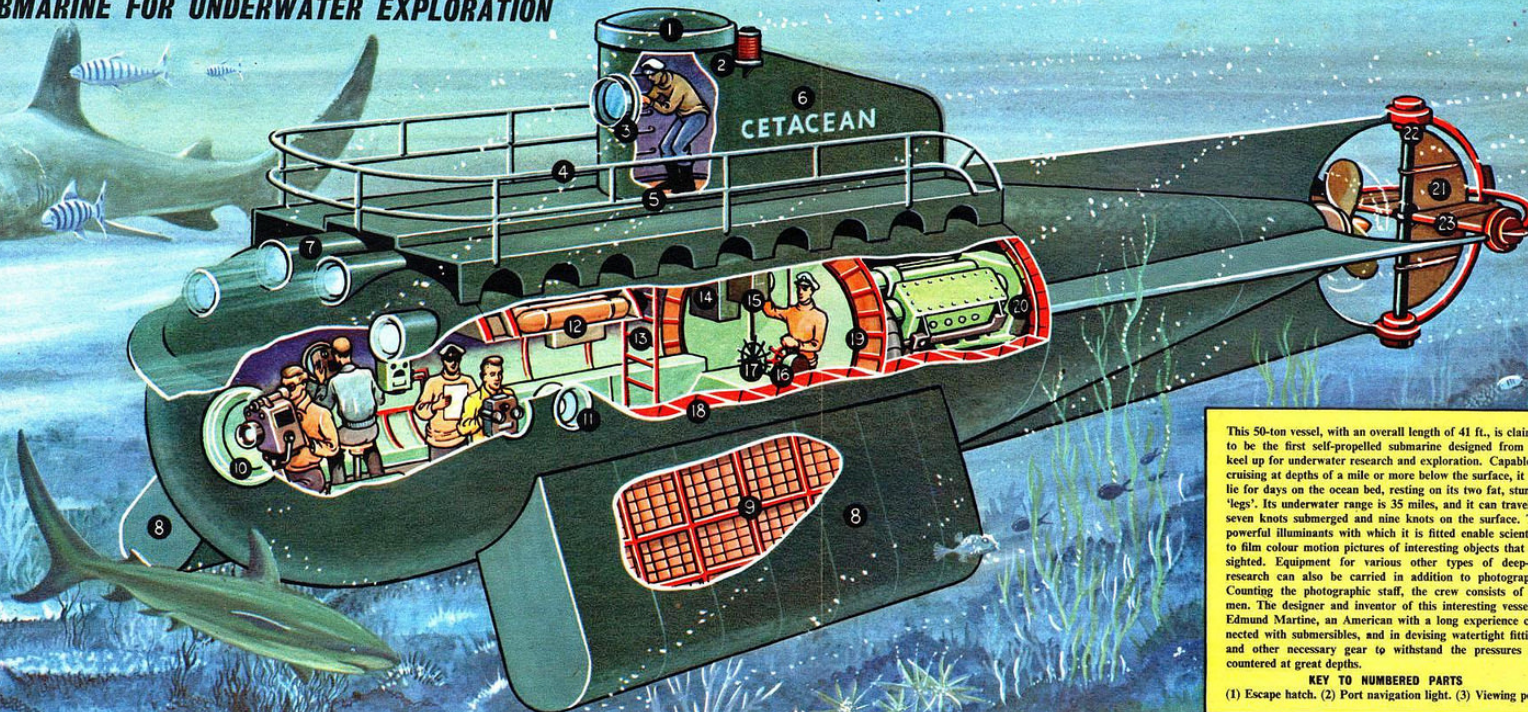
## KEY TO BELOW DECKS

(24) Exhaust trunk from engine rooms. (25) Hangar flap down. These flaps enable aircraft to be taken on board direct to hangar, without flying on and using the lifts. (26) Starboard propellers. (27) After aircraft hangars. (28) After starboard engine room. (29) Forward starboard engine-room. (30) Atomic pile producing enormous heat energy. (31) Heat exchangers producing enough steam to supply all the turbines and auxiliaries continuously. (32) Heavy shielding against radiation from atomic pile. (33) Former oil fuel space can now be used for storage of aircraft jet fuel. (34) Hangar flap down. (35) Forward aircraft hangars. (36) Crew spaces, etc. (37) Guided missile loading room.

Comparison of space occupied by atomic plant and that of the conventional types of steam boilers with their funnel uptakes, all of which can be dispensed with.



# CETACEAN—A SUBMARINE FOR UNDERWATER EXPLORATION



This 50-ton vessel, with an overall length of 41 ft., is claimed to be the first self-propelled submarine designed from the keel up for underwater research and exploration. Capable of cruising at depths of a mile or more below the surface, it can lie for days on the ocean bed, resting on its two fat, stumpy 'legs'. Its underwater range is 35 miles, and it can travel at seven knots submerged and nine knots on the surface. The powerful illuminants with which it is fitted enable scientists to film colour motion pictures of interesting objects that are sighted. Equipment for various other types of deep-sea research can also be carried in addition to photography. Counting the photographic staff, the crew consists of six men. The designer and inventor of this interesting vessel is Edmund Martine, an American with a long experience connected with submersibles, and in devising watertight fittings and other necessary gear to withstand the pressures encountered at great depths.

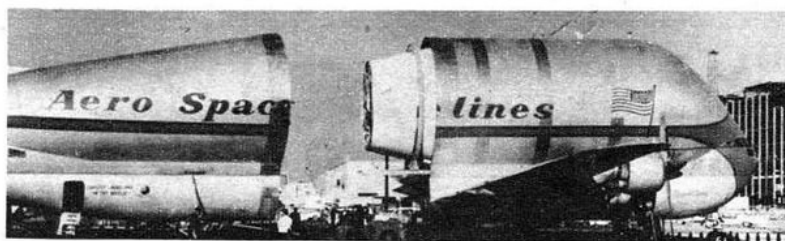
## KEY TO NUMBERED PARTS

(1) Escape hatch. (2) Port navigation light. (3) Viewing port.

(4) Safety rail for outer deck. (5) Inner hatch. (6) The definition of the word *Cetacean* is 'animal of the whale kind'. The submarine's name is, therefore, highly appropriate. (7) Forward facing battery of powerful lamps. (8) 'Legs', on which the vessel can rest on the ocean bed. (9) Seven tons of storage batteries are carried within the 'legs'. (10) Camera port fitted with glass, eight inches thick. (11) Side-light port. (12) Oxygen bottles and air purification equipment. (13) Communicating ladder to upper viewing chamber. (14) Engine and buoyancy-controls housing. (15) Instrument panel. (16) Control for diving vanes. (17) Steering wheel. (18) Double hull, containing water ballast and 2,000 gallons of fuel. The former is for controlling buoyancy during dives and ascents. In an emergency, the double pressure hull could withstand the squeeze that would be encountered at a depth of five miles. (19) Bulkhead. (20) Engine-room, containing a 150 h.p. Diesel engine, which drives the craft on the surface, and an electric motor for underwater propulsion. (21) Rudder. (22) Bearing housings. (23) Diving vanes.



# PLANE THAT SPLITS IN HALF



And here's to prove it! It's easy to remove the giant Saturn rocket section from the plane once the rear has been moved away

Then came the first of many flight tests to see if this addition caused any serious complications. There were no changes in flight characteristics, so the next stage was started. An extra-large blister was built over the existing fuselage, enabling flight testing to be carried out without interruption.

In spite of all the extra weight, the top speed was only reduced by 15 m.p.h. The designers satisfied, the inner fuselage was then removed.

After 50 hours of flight testing, operations went ahead to split the fuselage just behind the trailing edge of the wing. At first, this did not seem to present many problems but, in fact, it proved to be an enormous design change.

Controls to the tail control surfaces, hydraulic lines, and electrical cables had to be made in such a way that they could be parted and then refixed easily. Also, strong and efficient fixing points had to be designed if the machine was not to lose its tail in the air!

In October, 1962, the finished aircraft was flown to important military bases by Dr Werner von Braun, the rocket expert who is in charge of the National Aeronautics and Space Administration.

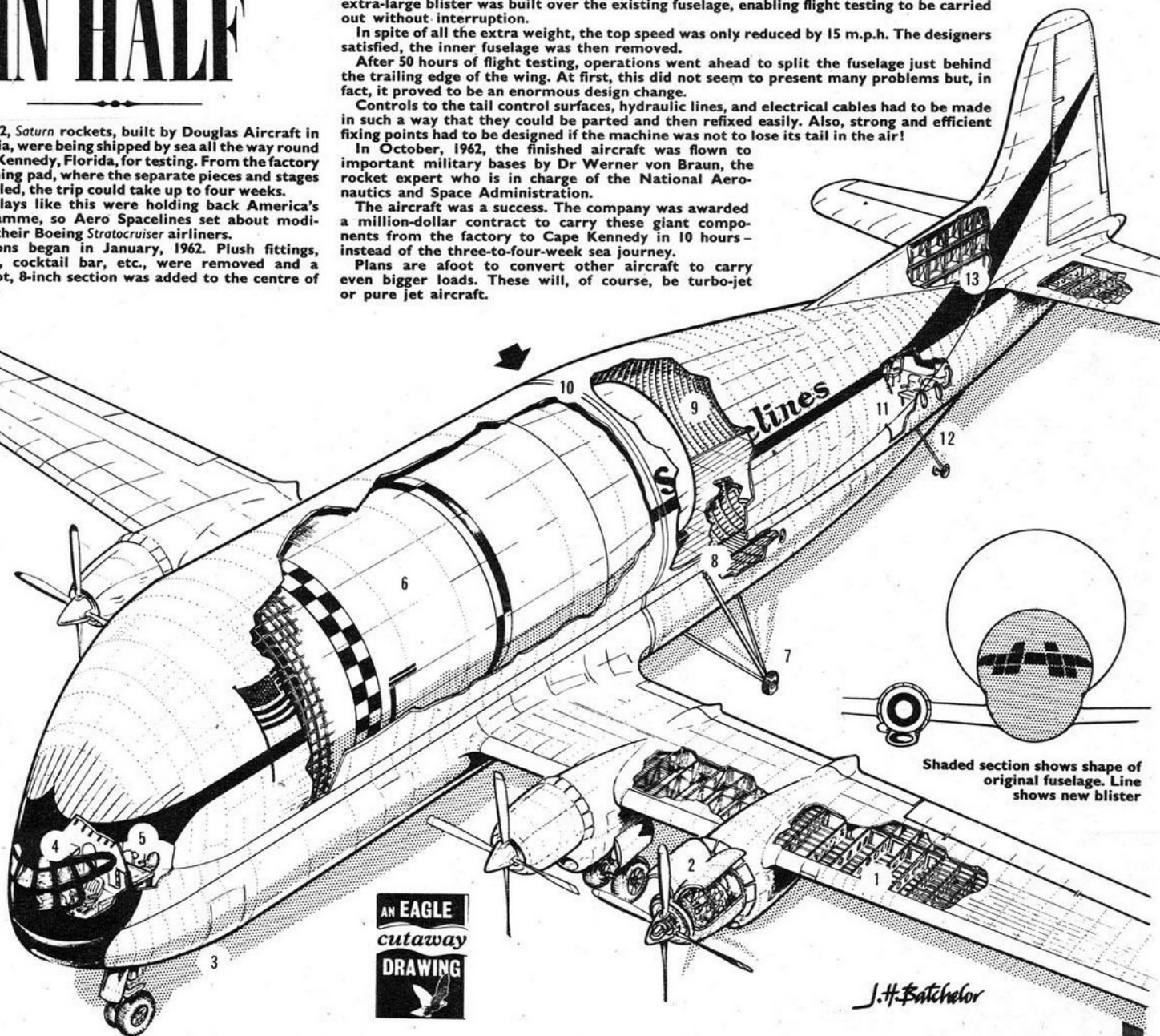
The aircraft was a success. The company was awarded a million-dollar contract to carry these giant components from the factory to Cape Kennedy in 10 hours - instead of the three-to-four-week sea journey.

Plans are afoot to convert other aircraft to carry even bigger loads. These will, of course, be turbo-jet or pure jet aircraft.

UNTIL 1962, Saturn rockets, built by Douglas Aircraft in California, were being shipped by sea all the way round to Cape Kennedy, Florida, for testing. From the factory to the launching pad, where the separate pieces and stages were assembled, the trip could take up to four weeks.

Serious delays like this were holding back America's space programme, so Aero Spacelines set about modifying one of their Boeing Stratocruiser airliners.

Modifications began in January, 1962. Plush fittings, seats, galley, cocktail bar, etc., were removed and a special 16-foot, 8-inch section was added to the centre of the fuselage.



Shaded section shows shape of original fuselage. Line shows new blister

AN EAGLE  
cutaway  
DRAWING

Length - 126 feet 8 inches  
Overall height - 38 feet 3 inches  
Span - 141 feet 3 inches  
Unloaded weight - 91,000 lb.

## KEY TO NUMBERED PARTS

(1) Wing structure containing fuel tanks. Enough fuel is carried to enable the aircraft to fly non-stop across the U.S.A. (2) Four Pratt and Whitney 28-cylinder, supercharged radial engines - developing

3,500 h.p. (3) Lower bay is fitted with all-weather radar. (4) Standard Stratocruiser cockpit, but with all the latest devices, including an auto-pilot. (5) Navigator's room. Flight engineer on starboard side. (6) The second stage of a Saturn rocket. This monster cargo is 41 feet long and 18 feet 6 inches wide. To enable it to go inside, the diameter of the Guppy was enlarged to 20 feet 4 inches. The height of the cabin was raised from 8 feet 10 inches to 21 feet. This more than tripled the original capacity - making a total of 29,187 cubic feet. Volume-wise, this makes it the biggest aeroplane in the world! (7) This dolly is not a permanent fixture. On landing, it is attached in the position shown. When the fuselage is 'broken', it rides back on these. The back of the plane can then be

wheeled out of the way. (8) Because the cargo takes up so much room, a walkway is provided through the lower fuselage. (9) Rear fuselage is usually empty, except for very light equipment. This is to keep the Saturn over the centre of gravity. (10) Splitting point. In flight, the tail section is bolted to the rest of the Guppy with 32 bolts and 13 tapered guide pins worked by 45 hydraulic cylinders. Four separate hydraulic systems work these as a safety factor. (11) A few lightweight seats are provided for technicians, etc., travelling with the cargo. The interior is very Spartan compared with the passenger version. (12) Second dolly runner. (13) The only change to control and stabilizer surfaces is the addition of area to the dorsal fairing to help guide airflow over the fin and rudder.



# A LOCOMOTIVE DEPOT AT WORK

This is an ideal layout for a Motive Power Depot, as it is correctly called, of the "through road" type, that is, the tracks run parallel through the engine shed thus taking up less space than the roundhouse type where the tracks radiate from a central turntable.

In these sheds the locomotive receives every attention necessary to keeping it in running order. The numbered stages show the series of operations from the time the locomotive backs in from its last journey until it is ready again for the next. The types of locomotives shown are the new standard ones of British Railways in three colour schemes.

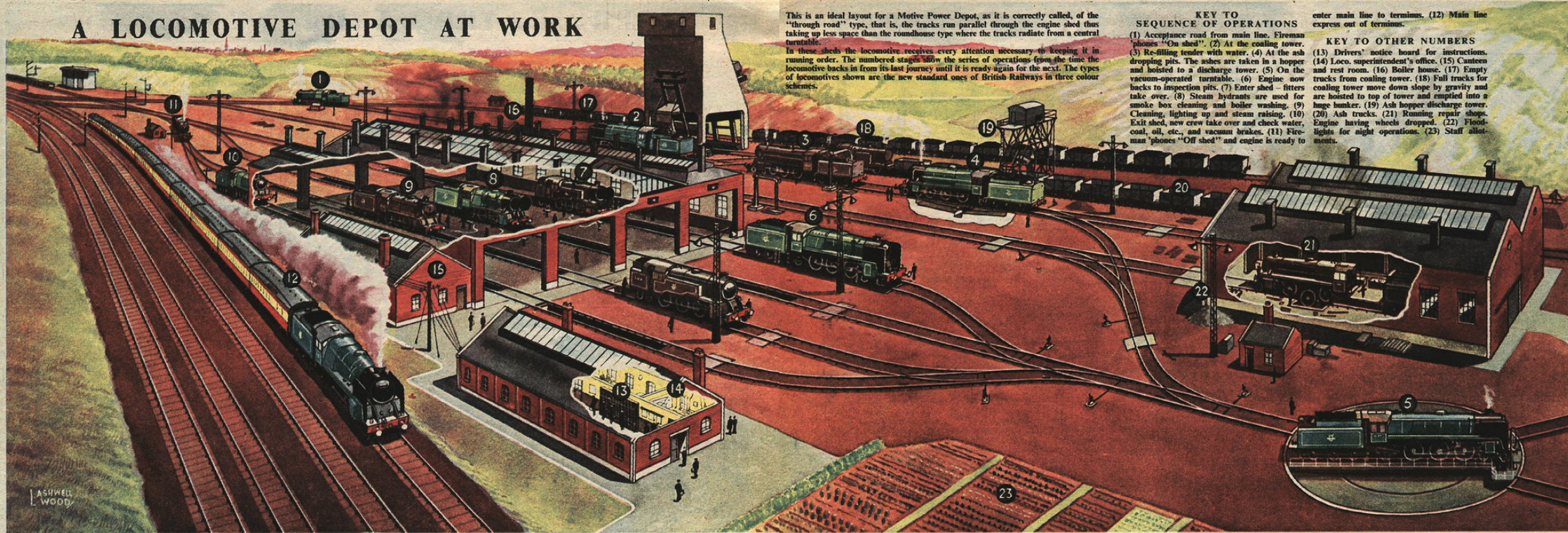
## SEQUENCE OF OPERATIONS

(1) Acceptance road from main line. Fireman 'phones "On shed". (2) At the coaling tower. (3) Re-filling tender with water. (4) At the ash dropping pits. The ashes are taken in a hopper and hoisted to a discharge tower. (5) On the vacuum-operated turntable. (6) Engine now backs to inspection pits. (7) Enter shed - fitters take over. (8) Steam hydrants are used for smoke box cleaning and boiler washing. (9) Cleaning, lighting up and steam raising. (10) Exit shed, new crew take over and check water, coal, oil, etc., and vacuum brakes. (11) Fireman 'phones "Off shed" and engine is ready to

enter main line to terminus. (12) Main line express out of terminus.

## KEY TO OTHER NUMBERS

(13) Drivers' notice board for instructions. (14) Loco. superintendent's office. (15) Canteen and rest room. (16) Boiler house. (17) Empty trucks from coaling tower. (18) Full trucks for coaling tower move down slope by gravity and are hoisted to top of tower and emptied into a huge bunker. (19) Ash hopper discharge tower. (20) Ash trucks. (21) Running repair shops. Engine having wheels dropped. (22) Floodlights for night operations. (23) Staff allotments.





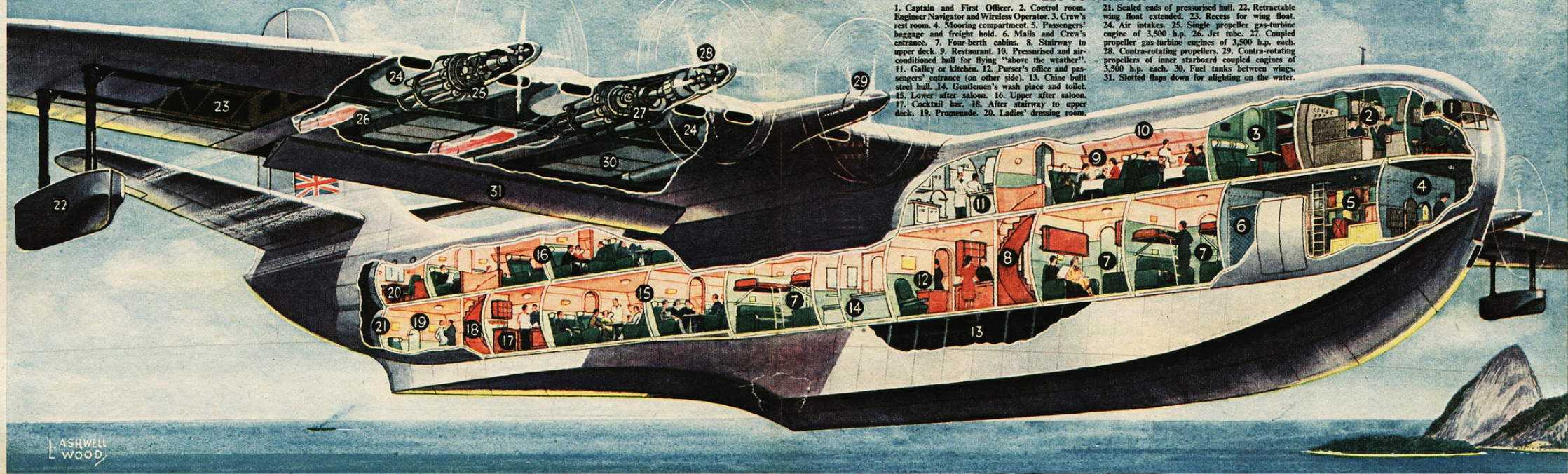
# THE SAUNDERS-ROE "PRINCESS" MONSTER FLYING-BOAT

Three of these 140-ton flying-boats are under construction for the world's longest stage air routes, carrying 104 passengers. They are powered by ten Bristol Proteus propeller gas-turbines giving a total power output of 35,000 h.p. We show an interior design scheme for one arriving at Rio de Janeiro on the South American route.

## KEY TO NUMBERS

1. Captain and First Officer. 2. Control room. Engineer Navigator and Wireless Operator. 3. Crew's rest room. 4. Mooring compartment. 5. Passengers' baggage and freight hold. 6. Mails and Crew's entrance. 7. Four-berth cabins. 8. Stairway to upper deck. 9. Restaurant. 10. Pressurised and air-conditioned hull for flying "above the weather". 11. Galley or kitchen. 12. Purser's office and passengers' entrance (on other side). 13. Chine built steel hull. 14. Gentlemen's wash place and toilet. 15. Lower after saloon. 16. Upper after saloon. 17. Cocktail bar. 18. After stairway to upper deck. 19. Promenade. 20. Ladies' dressing room.

21. Sealed ends of pressurised hull. 22. Retractable wing float extended. 23. Recess for wing float. 24. Air intakes. 25. Single propeller gas-turbine engine of 3,500 h.p. 26. Jet tube. 27. Coupled propeller gas-turbine engines of 3,500 h.p. each. 28. Contra-rotating propellers. 29. Contra-rotating propellers of inner starboard coupled engines of 3,500 h.p. each. 30. Fuel tanks between wings. 31. Slotted flaps down for alighting on the water.







# SWING-WINGS IN THE AIR

UNTIL a few weeks ago, it seemed likely that the American TFX would replace Britain's TSR-2 strike aircraft. This plan is now in the balance but, as the TFX is undoubtedly one of the world's most advanced fighter-bombers, our cutaway drawing shows it making aviation history by changing its wing position in flight. At 1,650 m.p.h., the wings are in the swept back position (picture top right). At lower speeds, the wings are extended sideways (main picture). An unswept wing makes an aircraft easier to handle at low speeds, so, for take-off and landing, the wings of the TFX are extended sideways. At supersonic speeds, the wings are swept back on special hinges.

The General Dynamics TFX is powered by two Pratt & Whitney turbo-jet engines, each of 19,000 lb. thrust with reheat. It is a side-by-side two-seater fighter-bomber, equipped to carry conventional and nuclear weapons, including air-to-surface missiles. The TFX has less range and a smaller bomb-load than the TSR-2, but is considerably cheaper.

## KEY TO NUMBERED PARTS

(1) Probe for air-speed indicators. (2) Radar scanner. (3) Electronics and fire-power control system. (4) Ammunition container. (5) Nosewheels, retracted. (6) Guns. (7) Gun camera. (8) Pilot and navigator. (9) Crew escape capsule. (10) Weapons bay. (11) Fuel tanks. (12) Engine air inlet ducts—variable opening. (13) Main undercarriage, retracted. (14) Port wing pivot. (15) Wing operating jacks. (16) Starboard wing pivot. (17) Flap, airbrake and missile controls pass round

the wing pivot. (18) Fuel tanks. (19) Port engine. (20) Engine air intake vanes. (21) Starboard engine. (22) Position of wing when swept back. (23) Leading edge flaps. (24) Pivoting weapons pylon—keeps weapons in line with aircraft when wing is back. (25) Airbrakes, lowered. (26) Flaps. (27) Arc of swept back wing. (28) Moveable tail plane operates as elevons (i.e.—ailerons cum elevators). (29) Tail plane pivot. (30) Variable jet nozzle. (31) Swept fin and rudder.

## THE RIVALS COMPARED

(DRAWN TO SCALE)

American TFX. Length—72 ft. 1½ in. Span (extended)—63 ft. Span (swept back)—31 ft. 11½ in. Weight—65,000 lb.

British TSR-2. Length—90 ft. Span—35 ft. Weight—100,000 lb.

LASHWELL  
WOOD



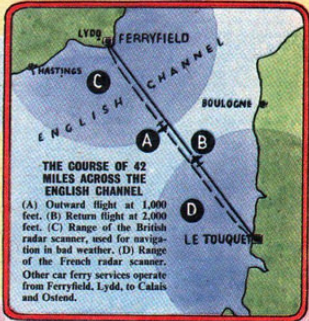
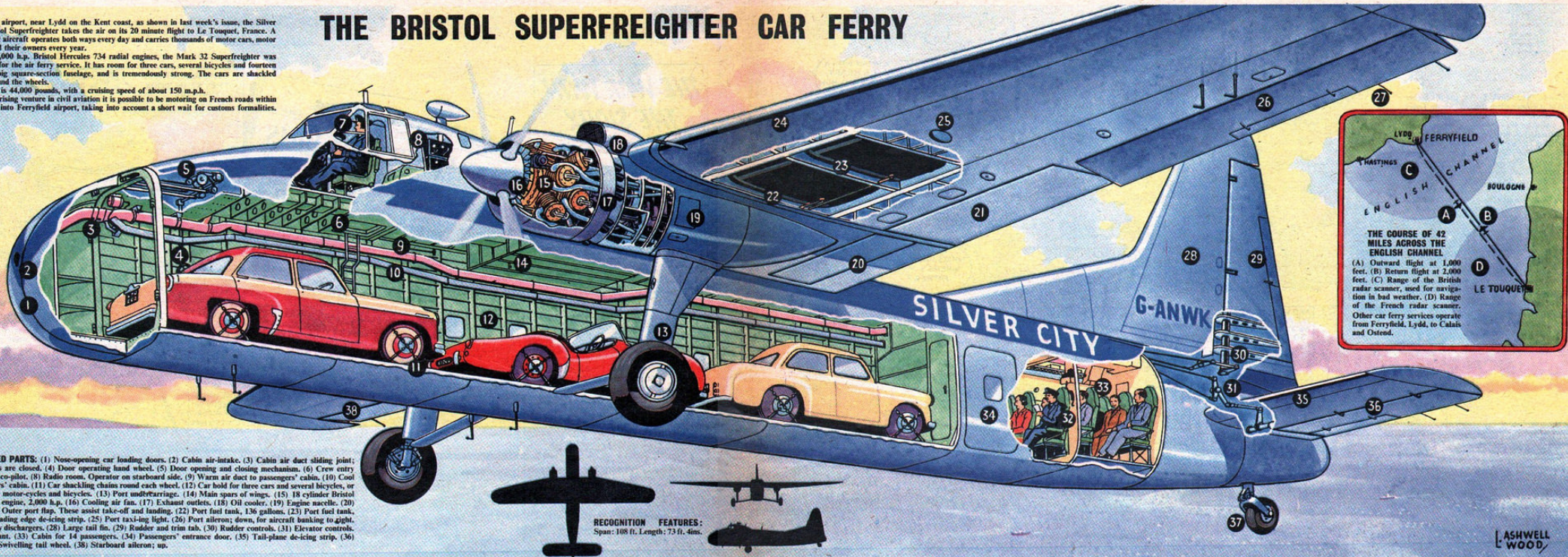
Leaving Ferryfield airport, near Lydd on the Kent coast, as shown in last week's issue, the Silver City Airways Bristol Superfreighter takes the air on its 20 minute flight to Le Touquet, France. A fleet of these robust aircraft operates both ways every day and carries thousands of motor cars, motor cycles, bicycles and their owners every year.

Powered by two 2,000 h.p. Bristol Hercules 734 radial engines, the Mark 32 Superfreighter was specially designed for the air ferry service. It has room for three cars, several bicycles and fourteen passengers in its big square-section fuselage, and is tremendously strong. The cars are shackled down by chains round the wheels.

The loaded weight is 44,000 pounds, with a cruising speed of about 150 m.p.h.

In this most enterprising venture in civil aviation it is possible to be motoring on French roads within an hour of driving into Ferryfield airport, taking into account a short wait for customs formalities.

## THE BRISTOL SUPERFREIGHTER CAR FERRY



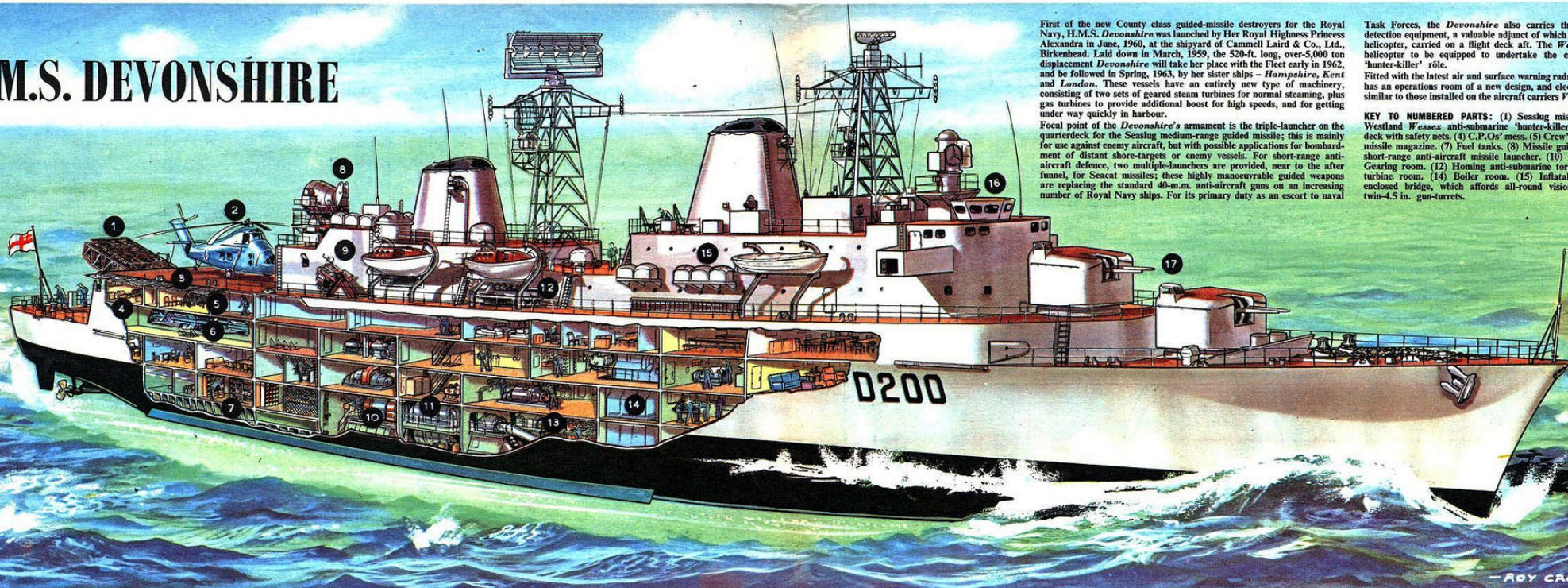
**KEY TO NUMBERED PARTS:** (1) Nose-opening car loading doors. (2) Cabin air-intake. (3) Cabin air duct sliding joint; connects when doors are closed. (4) Door operating hand wheel. (5) Door opening and closing mechanism. (6) Crew entry hatch. (7) Pilot and co-pilot. (8) Radio room. Operator on starboard side. (9) Warm air duct to passengers' cabin. (10) Cool air duct to passengers' cabin. (11) Car shackling chains round each wheel. (12) Car hold for three cars and several bicycles, or two cars and several motor-cycles and bicycles. (13) Port undercarriage. (14) Main spars of wings. (15) 18 cylinder Bristol Hercules 734 radial engine, 2,000 h.p. (16) Cooling air fan. (17) Exhaust outlets. (18) Oil cooler. (19) Engine nacelle. (20) Inner port flap. (21) Outer port flap. These assist take-off and landing. (22) Port fuel tank, 136 gallons. (23) Port fuel tank, 100 gallons. (24) Landing edge de-icing strip. (25) Port taxiing light. (26) Port aileron; down, for aircraft banking to right. (27) Static electricity dischargers. (28) Large tail fin. (29) Rudder and trim tab. (30) Rudder controls. (31) Elevator controls. (32) Official attendant. (33) Cabin for 14 passengers. (34) Passengers' entrance door. (35) Tail-plane de-icing strip. (36) Port elevator. (37) Swivelling tail wheel. (38) Starboard aileron; up.

**RECOGNITION FEATURES:**  
Span: 108 ft. Length: 73 ft. 4ins.

ASHWELL  
WOOD



# H.M.S. DEVONSHIRE



First of the new County class guided-missile destroyers for the Royal Navy, H.M.S. *Devonshire* was launched by Her Royal Highness Princess Alexandra in June, 1960, at the shipyard of Cammell Laird & Co., Ltd., Birkenhead. Laid down in March, 1959, the 520-ft. long, over-5,000 ton displacement *Devonshire* will take her place with the Fleet early in 1962, and be followed in Spring, 1963, by her sister ships - *Hampshire*, *Kent* and *London*. These vessels have an entirely new type of machinery, consisting of two sets of geared steam turbines for normal steaming, plus gas turbines to provide additional boost for high speeds, and for getting under way quickly in harbour.

Focal point of the *Devonshire's* armament is the triple-launcher on the quarterdeck for the Seaslug medium-range guided missile; this is mainly for use against enemy aircraft, but with possible applications for bombardment of distant shore-targets or enemy vessels. For short-range anti-aircraft defence, two multiple-launchers are provided, near to the after funnel, for Seacat missiles; these highly manoeuvrable guided weapons are replacing the standard 40-m.m. anti-aircraft guns on an increasing number of Royal Navy ships. For its primary duty as an escort to naval

Task Forces, the *Devonshire* also carries the latest anti-submarine detection equipment, a valuable adjunct of which is the Westland *Wessex* helicopter, carried on a flight deck aft. The *Wessex* is the first British helicopter to be equipped to undertake the complete anti-submarine 'hunter-killer' rôle.

Fitted with the latest air and surface warning radar, H.M.S. *Devonshire* has an operations room of a new design, and electronic plotting facilities similar to those installed on the aircraft carriers *Victorious* and *Hermes*.

**KEY TO NUMBERED PARTS:** (1) Seaslug missile triple-launcher. (2) Westland *Wessex* anti-submarine 'hunter-killer' helicopter. (3) Flight deck with safety nets. (4) C.P.O.'s mess. (5) Crew's dining hall. (6) Seaslug missile magazine. (7) Fuel tanks. (8) Missile guidance radar. (9) Seacat short-range anti-aircraft missile launcher. (10) Gas turbine room. (11) Gearing room. (12) Homing anti-submarine torpedo tubes. (13) Steam turbine room. (14) Boiler room. (15) Inflatable life-rafts. (16) The enclosed bridge, which affords all-round vision. (17) Radar-directed twin-4.5 in. gun-turrets.



# AIRSHIPS

## NEW PROJECTS FOR AN EXCITING REVIVAL

**THE AIRFLOAT HL**  
Towing its detachable refuelling blimp

Blimp's radio controlled  
manoeuvring motor

Fore & aft  
swivelling motors

Swivelling propellers  
to provide vertical or  
horizontal thrust

Flight &  
cargo loading  
control cabins  
Loading winches  
in freight module  
Compensating  
ballast when  
loading or unloading

Computer controlled fins at nose & tail  
adjust to flight conditions  
10 Rolls-Royce Proteus turbines

**THE ALL-AMERICAN INDUSTRIES  
AEROCRANE**  
with self-propelled radial wings

**THE MORSE NUCLEAR AIRSHIP**

Lifts to skylounge

Nuclear reactor in 12 foot (3.66m.) dia. sphere operates  
a 4000 h.p. turbine driving  
60 foot (18.29m.) dia. contra-  
rotating propellers

Passenger or freight  
accommodation

18-seat plane in hangar

IN recent years there has been interest in future possibilities for advanced airships for carrying very heavy or awkward cargo and even as super-luxury passenger craft. The particular advantage they have is that they can hover in areas where conventional planes or surface transport could not operate to unload cargo. Designers and engineers in Britain, America, Germany and Russia have been working on projects for huge airships using safer fuels than the highly inflammable hydrogen that

brought disaster to famous airships of the 1930s.

The British AIRFLOAT HL (Heavy Lift) is designed to lift 400 to 500 tonnes in large detachable freight modules or on winched-up frames for oversize loads. Natural gas would provide lift for the airship, with extra fuel to make it independent of a fixed base, towed behind in a 'Blimp' with its own radio controlled engine for independent manoeuvring

and ease of handling when detached.

The American MORSE NUCLEAR design is twice the size of the famous German pre-war HINDENBURG and would be able to carry very large loads and circle the Earth repeatedly without refuelling. A number of 'Hybrids' are also under consideration — huge aircraft combining airship buoyancy with features of conventional planes for propulsion and control.

**Date Sighted...**  
**Location...**



There are one or two airships that you can see floating majestically across the sky these days. If you spot one, award yourself 10 points, and make a note of when and where you saw it in the space on the right.

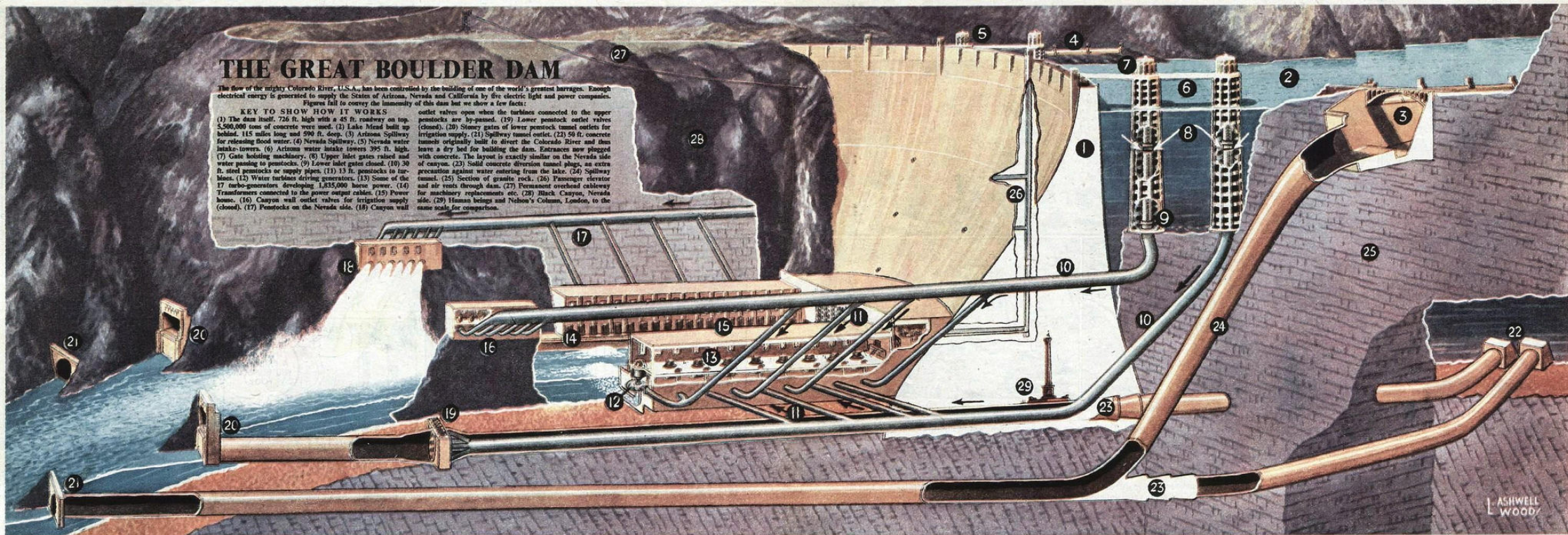


# THE GREAT BOULDER DAM

The flow of the mighty Colorado River, U.S.A., has been controlled by the building of one of the world's greatest barrages. Enough electrical energy is generated to supply the States of Arizona, Nevada and California by five electric light and power companies. Figures fail to convey the immensity of this dam but we show a few facts:

## KEY TO SHOW HOW IT WORKS

(1) The dam itself, 726 ft. high with a 45 ft. roadway on top. 5,500,000 tons of concrete were used. (2) Lake Mead built up behind, 115 miles long and 590 ft. deep. (3) Arizona Spillway for releasing flood water. (4) Nevada Spillway. (5) Nevada water intake towers. (6) Arizona water intake towers 395 ft. high. (7) Gate holding machinery. (8) Upper inlet gates raised and water passing to penstocks. (9) Lower inlet gates closed. (10) 30 ft. steel penstocks or supply pipes. (11) 13 ft. penstocks to turbines. (12) Water turbines driving generators. (13) Some of the 17 turbo-generators developing 1,835,000 horse power. (14) Transformers connected to the power output cables. (15) Power house. (16) Canyon wall outlet valves for irrigation supply (closed). (17) Penstocks on the Nevada side. (18) Canyon wall outlet valves open when the turbines connected to the upper penstocks are by-passed. (19) Lower penstock outlet valves (closed). (20) Stoney gates of lower penstock tunnel outlets for irrigation supply. (21) Spillway tunnel outlet. (22) 50 ft. concrete tunnels originally built to divert the Colorado River and thus leave a dry bed for building the dam. Entrances now plugged with concrete. The layout is exactly similar on the Nevada side of canyon. (23) Solid concrete diversion tunnel plugs, an extra precaution against water entering from the lake. (24) Spillway tunnel. (25) Section of granite rock. (26) Passenger elevator and air vents through dam. (27) Permanent overhead cableway for machinery replacements etc. (28) Black Canyon, Nevada side. (29) Human beings and Nelson's Column, London, to the same scale for comparison.





# THE "AIR HORSE" HELICOPTER

One of the world's largest helicopters, the Saunders Roe-Cierva "Air Horse", is of outstanding design and can lift the heaviest load (11 tons) ever to be raised by the aid of rotors. The aft compartment can also be converted to carry 24 passengers.

We show it here being used for spraying crops with insecticide for pest control. The great manoeuvrability of the helicopter makes it ideal for this purpose.

The three 47 ft. rotors are driven by a 1,620 h.p. Rolls-Royce Merlin 24 engine. The cruising speed is 116 miles per hour, or the helicopter can hover practically stationary. Vertical rate of climb 790 ft. per minute.

## KEY TO HOW IT WORKS

(1) 1,620 h.p. Rolls-Royce Merlin 24 engine. (2) Carburettor air intake and filter. (3) Engine exhaust. (4) Distribution gear box. Here the drive is distributed to the three rotor shafts and also to the oil cooling fan and pest control spray pump. (5-5) Rotor-head drive shafts. (6-6) Bevel drive reduction gearing. (7-7) Variable pitch rotor blades, 47 ft. long. (8-8) Spider control for pitch and tilt of rotors. The angle of tilt of the rotors is called "cyclic pitch". This is what enables the machine to fly forwards, backwards and sideways. The up and down movement of the spider changes the pitch of the blades to provide greater or lesser lift. This is known as "collective pitch". The diagrams on the right explain how this works. (9-9) Up and down "collective pitch" control wires. (10-10) Tilting or "cyclic pitch" control wires. (11) Control cabinet. Here the "collective and cyclic pitch" controls are operated by hydraulic jacks, which are controlled, in turn, from the cockpit. (12) "Cyclic pitch" control foot pedals. (13) "Collective pitch" control for all three rotors. (14) "Collective pitch" control for individual rotors. (15) Engine controls. (16) Pilot and co-pilot with dual control. (17-17) Oil-pneumatic shock absorbing undercarriage legs. These are capable of great movement to absorb the weight of the aircraft when landing vertically. (18) Nose wheel leg goes right through to roof. (19) Entrance to engine room. Crew's entrance door is on the port side. (20) Air inlet for oil cooler. (21) Engine-driven fan in wind tunnel. (22) Oil cooler. (23) Cooling air outlet. (24) Pest control spray pump. (25) Hoppers of insecticide powder for spraying. (26) Spraying nozzle. (27) Convertible compartment for 11 tons of freight or 24 passengers. (28) Passengers' door. (29) Split tail doors open out, complete with fins, for loading heavy freight. (30) Rotor head support strut. (31) Moveable fins (not rudders) give directional trim in forward flight. (32) Air speed indicator. (33) Petrol tank; 157 gallons.

VERTICAL FLIGHT

FORWARD FLIGHT

BACKWARD FLIGHT

SIDWAYS FLIGHT TO PORT

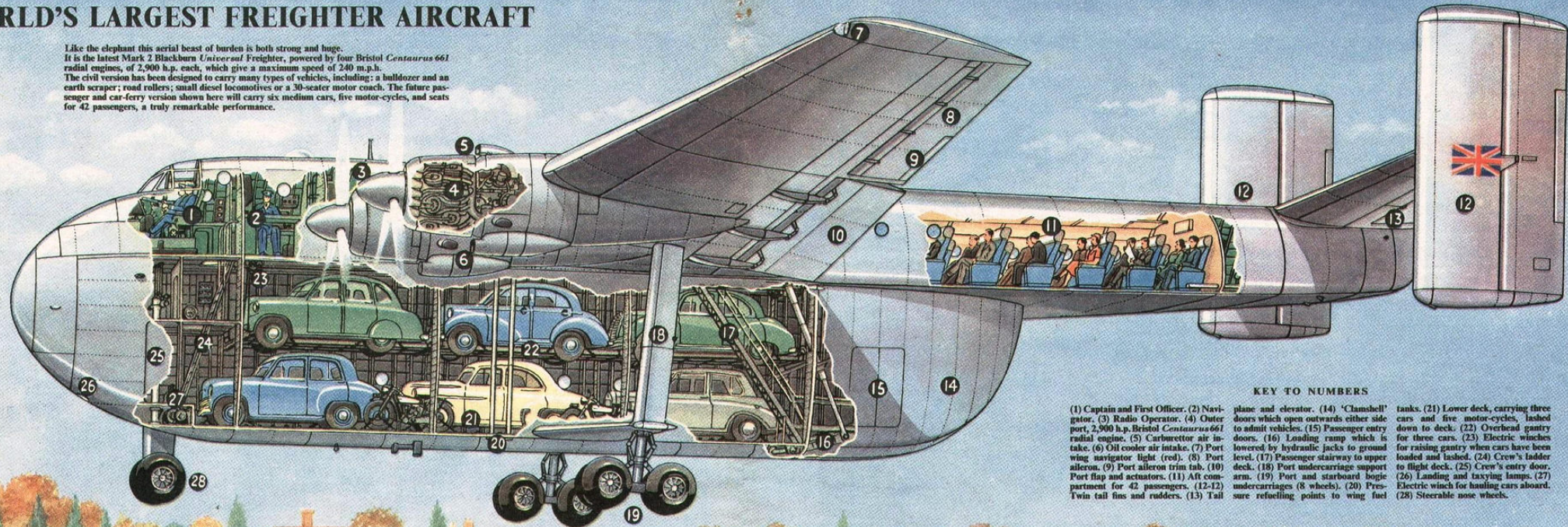
SIDWAYS FLIGHT TO STARBOARD

How flight is controlled by altering the pitch of the blades - "collective pitch" - and the pitch or tilt of the whole rotor - "cyclic pitch".



# WORLD'S LARGEST FREIGHTER AIRCRAFT

Like the elephant this aerial beast of burden is both strong and huge. It is the latest Mark 2 Blackburn *Universal Freighter*, powered by four Bristol *Centaurus* 661 radial engines, of 2,900 h.p. each, which give a maximum speed of 240 m.p.h. The civil version has been designed to carry many types of vehicles, including: a bulldozer and an earth scraper; road rollers; small diesel locomotives or a 30-seater motor coach. The future passenger and car-ferry version shown here will carry six medium cars, five motor-cycles, and seats for 42 passengers, a truly remarkable performance.



## KEY TO NUMBERS

(1) Captain and First Officer. (2) Navigator. (3) Radio Operator. (4) Outer port, 2,900 h.p. Bristol *Centaurus* 661 radial engine. (5) Carburettor air intake. (6) Oil cooler air intake. (7) Port wing navigator light (red). (8) Port aileron. (9) Port aileron trim tab. (10) Port flap and actuators. (11) Aft compartment for 42 passengers. (12-13) Electric winch for hauling cars aboard. (14) 'Clamshell' doors which open outwards either side to admit vehicles. (15) Passenger entry doors. (16) Loading ramp which is lowered by hydraulic jacks to ground level. (17) Passenger stairway to upper deck. (18) Port undercarriage support arm. (19) Port and starboard bogie undercarriages (8 wheels). (20) Pressure refuelling points to wing fuel tanks. (21) Lower deck, carrying three cars and five motor-cycles, lashed down to deck. (22) Overhead gantry for three cars. (23) Electric winches for raising gantry when cars have been loaded and lashed. (24) Crew's ladder to flight deck. (25) Crew's entry door. (26) Landing and taxiing lamps. (27) Electric winch for hauling cars aboard. (28) Steerable nose wheels.



YOU have probably all noticed the lorries which are made in two sections, a front part with the motor, which can be joined on to any of its several different types of trucks.

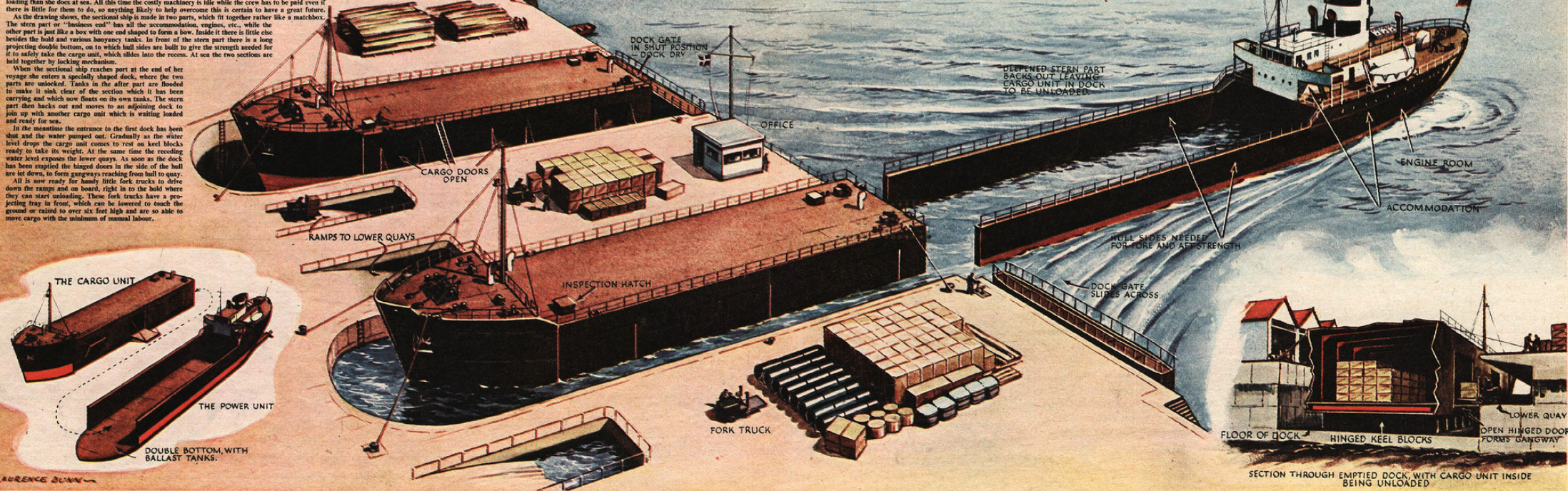
New naval architects have copied the idea and a design for a sectional ship has just been patented in America. Where ships trade regularly between two ports, say on coastal or cross-channel runs, the idea offers very great economies. Nowadays a cargo ship often has to spend more time in port loading or unloading than she does at sea. All this time the costly machinery is idle while the crew has to be paid even if there is little for them to do, so anything likely to help overcome this is certain to have a great future.

As the drawing shows, the sectional ship is made in two parts, which fit together rather like a matchbox. The stern part or "business end" has all the accommodation, engines, etc., while the other part is just like a box with one end shaped to form a bow. Inside it there is little else besides the hold and various buoyancy tanks. In front of the stern part there is a long projecting double bottom, on to which hull sides are built to give the strength needed for it to safely take the cargo unit, which slides into the recess. At sea the two sections are held together by locking mechanism.

When the sectional ship reaches port at the end of her voyage she enters a specially shaped dock, where the two parts are unlocked. Tanks in the after part are flooded to make it sink clear of the section which it has been carrying, and which now floats on its own tanks. The stern part then backs out and moves to an adjoining dock to join up with another cargo unit which is waiting loaded and ready for sea.

In the meantime the entrance to the first dock has been shut and the water pumped out. Gradually as the water level drops the cargo unit comes to rest on keel blocks ready to take its weight. At the same time the receding water level exposes the lower quays. As soon as the dock has been emptied the hinged doors in the side of the hull are let down, to form gangways reaching from hull to quay. All is now ready for handy little fork trucks to drive down the ramps and on board, right in to the hold where they can start unloading. These fork trucks have a projecting tray in front, which can be lowered to touch the ground or raised to over six feet high and are so able to move cargo with the minimum of manual labour.

# THE SECTIONAL SHIP





This famous express of South African Railways runs regularly between Capetown and Johannesburg, via Kimberley. The "15F" class locomotives are British built, and are among the most powerful in the world on the 3 ft. 6 in. gauge. They are 4-8-2 locomotives, are 74 ft. long and weigh, loaded, 180 tons.

# KEY TO HOW IT WORKS

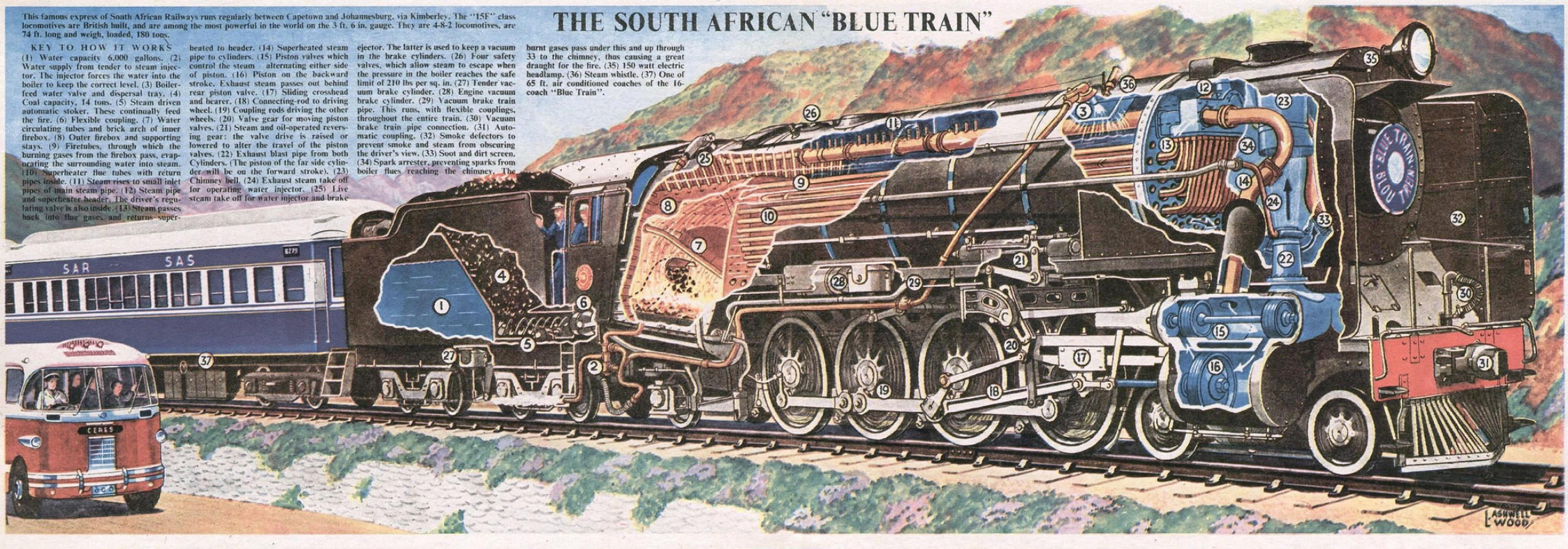
(1) Water capacity 6,000 gallons. (2) Water supply from tender to steam injector. The injector forces the water into the boiler to keep the correct level. (3) Boiler-feed water valve and dispersal tray. (4) Coal capacity, 14 tons. (5) Steam driven automatic stoker. These continually feed the fire. (6) Flexible coupling. (7) Water circulating tubes and brick arch of inner firebox. (8) Outer firebox and supporting stays. (9) Firetubes, through which the burning gases from the firebox pass, evaporating the surrounding water into steam. (10) Superheater flue tubes with return pipes inside. (11) Steam rises to small inlet pipes of main steam pipe. (12) Steam pipe and superheater header. The driver's regulating valve is also inside. (13) Steam passes back into flue gases, and returns super-

heated to header. (14) Superheated steam pipe to cylinders. (15) Piston valves which control the steam - alternating either side of piston. (16) Piston on the backward stroke. Exhaust steam passes out behind rear piston valve. (17) Sliding crosshead and bearer. (18) Connecting rod to driving wheel. (19) Coupling rods driving the other wheels. (20) Valve gear for moving piston valves. (21) Steam and oil-operated reversing gear: the valve drive is raised or lowered to alter the travel of the piston valves. (22) Exhaust blast pipe from both cylinders. (The piston of the far side cylinder will be on the forward stroke). (23) Chimney bell. (24) Exhaust steam take off for operating water injector. (25) Live steam take off for water injector and brake

ejector. The latter is used to keep a vacuum in the brake cylinders. (26) Four safety valves, which allow steam to escape when the pressure in the boiler reaches the safe limit of 210 lbs per sq. in. (27) Tender vacuum brake cylinder. (28) Engine vacuum brake cylinder. (29) Vacuum brake train pipe. This runs, with flexible couplings, throughout the entire train. (30) Vacuum brake train pipe connection. (31) Automatic coupling. (32) Smoke deflectors to prevent smoke and steam from obscuring the driver's view. (33) Soot and dirt screen. (34) Spark arrester, preventing sparks from boiler flues reaching the chimney. The

burnt gases pass under this and up through 33 to the chimney, thus causing a great draught for the fire. (35) 150 watt electric headlamp. (36) Steam whistle. (37) One of 65 ft. air conditioned coaches of the 16-coach "Blue Train".

# THE SOUTH AFRICAN "BLUE TRAIN"





# DRYDOCKING AN 83,000 TON GIANT

Situated at Southampton is the world's largest graving dock, the King George V dock, shown here with the world's largest ship, the "Queen Elizabeth", inside it. The dock is 1,200 feet long, 135 feet wide and 59 feet deep. It has a capacity of 58,000,000 gallons of water.

After a vessel has entered the dock and the sliding steel caisson, weighing 1,800 tons has been closed, the water can be pumped out by the four main pumps each of which has a capacity of discharging 78,000 gallons a minute into the river.

The ship settles down on a long line of keel blocks and on either side of these there are two lines on "bilge" blocks which support the ship in an upright position.

When the ship's bottom has been cleaned and painted, water is admitted by gravity from the outside level, the caisson opened and the ship towed out by tugs.

## KEY TO NUMBERS

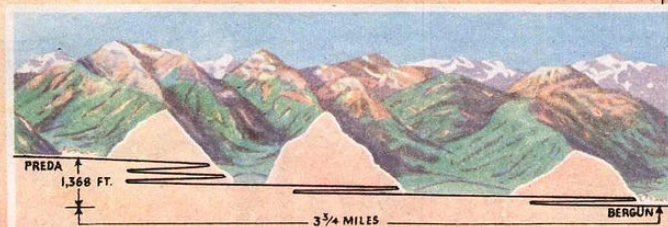
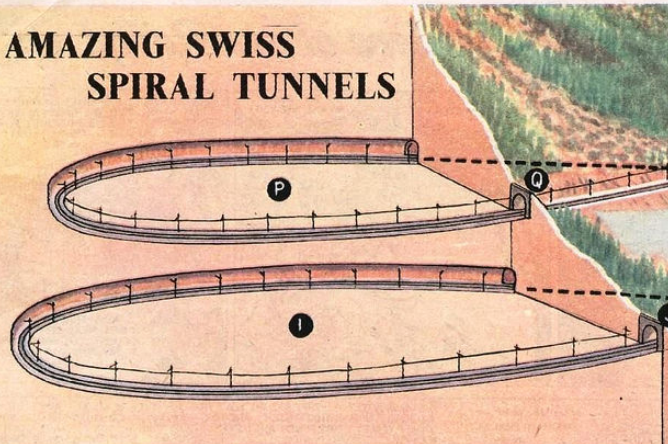
- (1) Southampton water. (2) River Test. (3) 1,800 ton sliding caisson closed. (4) Water ballast in caisson. (5) Recess for caisson. (6) Motor house for caisson. (7) Control room where all valves and pumps are controlled by electric push buttons. (8) Valve house. (9) Pump and culvert chamber. (10) Centre line keel blocks. (11) Propellers are cleaned or removed. (12) Barnacles, which after a time impede the speed of a ship, are removed and bottom painted. (13) "Bilge" blocks which keep the ship in an upright position. (14) Floor of dock 25 feet thick. (15) Buttresses every 200 feet which prevent the ship, when floating, from touching the actual walls. (16) Travelling crane lifting 10 tons. (17) Travelling crane lifting 50 tons. (18) Capstans. (19) Anchors and chains lowered for cleaning.

## KEY TO THE ENLARGED PUMP CHAMBER

- (20) Water level when dock is filled. (21) Outside water level the same. (22) 1,250 h.p. electric pump motors. (23) Four main suction pumps. (24) 10 feet suction culverts and valves for emptying dock. (25) Main sumps from which water is drawn by pumps. (26) 10 feet water discharge culverts and valves. (27) Impounding suction culvert and valve for maintaining the difference in tide levels. (28) Impounding discharge culvert into dock. (29) 3 ft. drainage suction culvert and valve. (30) Drainage sump and pumps. (31) Drainage discharge culvert. (32) Storm or heavy rain water suction culvert. (33) Valves for future dock. (34) 10 ft. culverts from future dock site.



# AMAZING SWISS SPIRAL TUNNELS



## GAINING HEIGHT BY MEANS OF SPIRAL TUNNELS

Although Preda is only 3 1/4 miles as the crow flies from Bergun, and 1,368 ft. higher up the valley, the train travels 7 1/2 miles in making the ascent, at an average incline of 1 in 29. The natural incline is 1 in 14.

The "Glacier Express" runs through the heart of Switzerland from St Moritz to Zermatt, a distance of only 167 1/2 miles, but the difficulties of the route are stupendous. Every device of the railway engineer has been called into play to surmount the differences of level. Spiral sweeps and corkscrew tunnels abound, but the passengers' reward is a journey of entrancing beauty.

A particularly interesting section is shown here on the Rhaetian Railway in the Albula Valley, between Bergun and Preda, north of St Moritz.

Assuming we have left the spiral tunnel at Bergun on our 1,368 ft. climb to Preda, the key to the journey is as follows:-

- A. The Albula River.
- B. First viaduct over the river.
- C. Entrance to first spiral tunnel. Motor road above.
- D. Rugnux Tunnel - 724 yards long.
- E. Tunnel exit. Line has climbed 80 ft. in the spiral.
- F. Electric train of "Glacier Express".
- G. Second viaduct crossing the Albula.
- H. Entrance to second spiral tunnel.
- I. Toulva Tunnel - 740 yards long.
- J. Tunnel exit, 75 ft. higher up.
- K. Concrete retaining wall.
- L. Third viaduct crossing the Albula.
- M. Spiral sweep on other side of valley.
- N. Fourth viaduct crossing the Albula.
- O. Entrance to third spiral tunnel.
- P. Zuondra Tunnel - 586 yards long - immediately over the Toulva Tunnel.
- Q. Tunnel exit.
- R. Line continues to climb to Preda.



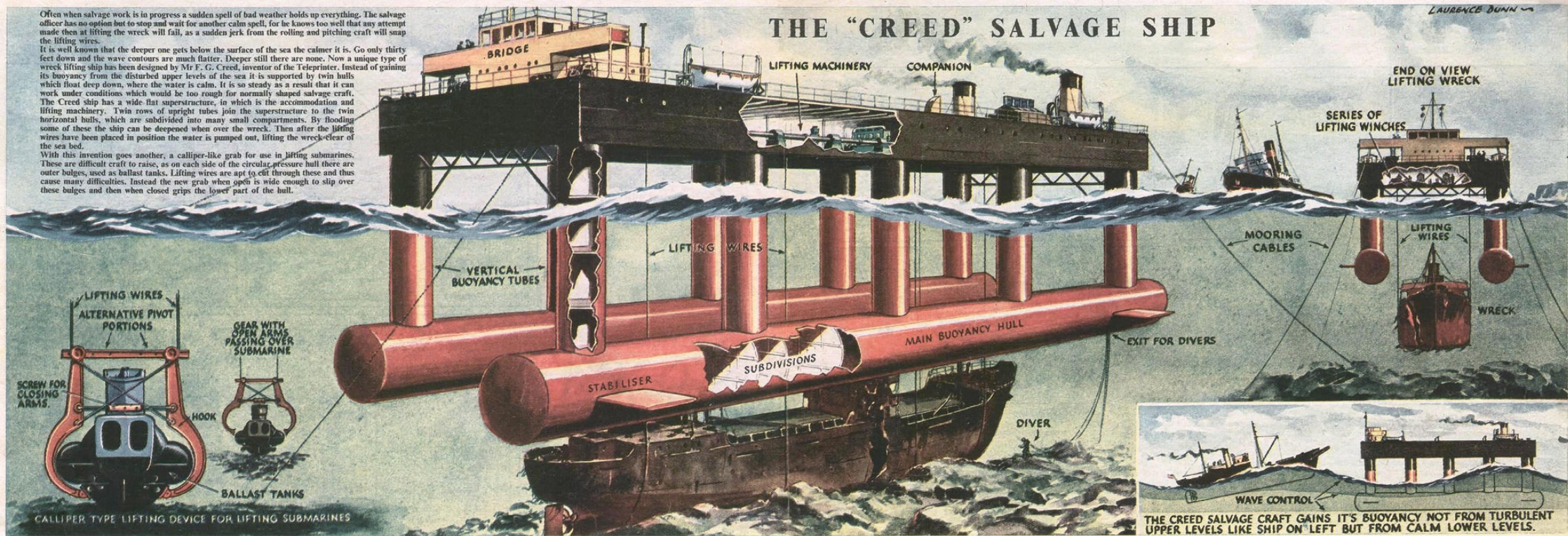
Often when salvage work is in progress a sudden spell of bad weather holds up everything. The salvage officer has no option but to stop and wait for another calm spell, for he knows too well that any attempt made then at lifting the wreck will fail, as a sudden jerk from the rolling and pitching craft will snap the lifting wires.

It is well known that the deeper one gets below the surface of the sea the calmer it is. Go only thirty feet down and the wave contours are much flatter. Deeper still there are none. Now a unique type of wreck lifting ship has been designed by Mr F. G. Creed, inventor of the Teleprinter. Instead of gaining its buoyancy from the disturbed upper levels of the sea it is supported by twin hulls which float deep down, where the water is calm. It is so steady as a result that it can work under conditions which would be too rough for normally shaped salvage craft. The Creed ship has a wide flat superstructure, in which is the accommodation and lifting machinery. Twin rows of upright tubes join the superstructure to the twin horizontal hulls, which are subdivided into many small compartments. By flooding some of these the ship can be deepened when over the wreck. Then after the lifting wires have been placed in position the water is pumped out, lifting the wreck clear of the sea bed.

With this invention goes another, a calliper-like grab for use in lifting submarines. These are difficult craft to raise, as on each side of the circular pressure hull there are outer bulges, used as ballast tanks. Lifting wires are apt to cut through these and thus cause many difficulties. Instead the new grab when open is wide enough to slip over these bulges and then when closed grips the lower part of the hull.

# THE "CREED" SALVAGE SHIP

LAURENCE BUNN



THE CREED SALVAGE CRAFT GAINS ITS BUOYANCY NOT FROM TURBULENT UPPER LEVELS LIKE SHIP ON LEFT BUT FROM CALM LOWER LEVELS.



# H.M. AIRCRAFT CARRIER *ALBION*

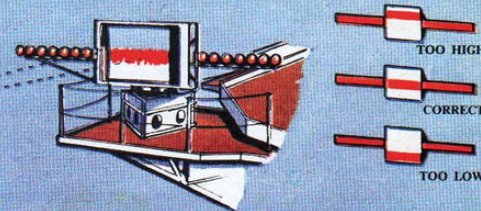
This new 18,000 ton Aircraft Carrier belongs to the *Hermes* class, of which three were completed in 1954, the others being named *BULWARK* and *CENTAUR*. The *ALBION* was built at Wallsend-on-Tyne by Swan Hunter & Wigham Richardson Ltd., and measures 737 ft. in overall length and 123 ft. in extreme breadth. She has a peacetime complement of approximately 1,300 officers and men. Two sets of geared turbines give a speed of some 30 knots.

These three ships are the first in the Royal Navy to be fitted with the new angled deck. If, while landing-on, an aircraft misses the arrestor wires, the pilot no longer faces running into the barrier, but merely opens his throttle and takes off to make another landing. As the diagrams show, the new arrangement also permits a much greater parking area for planes. In these ships the planes land at an angle of 5½ degrees to port, but in future carriers the flight deck will be made yet wider, so that this angle can be increased to one of about 10 degrees.

The *ALBION* is the first carrier to be fitted with the new Mirror Landing Sight. This device enables the pilot of an aircraft to come in and land on a predetermined flight path by keeping a reflected light in the centre of the mirror.

## MIRROR LANDING SIGHT

AS SEEN FROM APPROACHING PLANE



BEAM OF LIGHT  
REFLECTED  
FROM AFT

PREVIOUS  
FLIGHT DECK  
LAYOUT



Arrow points to BARRIER

H.M.S. *ALBION*,  
INTERIM STAGE -  
5½ DEGREES



Arrow points to PARKING AREA

U.S.S. *FORRESTAL*,  
NOW BUILDING -  
10 DEGREE ANGLE



Arrow points to SIDE LIFTS

## KEY TO DRAWING OF H.M.S. *ALBION*

(1) Aircraft catapults. (2) Mirror landing sight. (3) Lights reflecting into mirror. (4) Aircraft arrestor wires (six). (5) After aircraft lift. (6) Hangar space. (7) Radar gun control gear. (8) Navigating Bridge. (9) Ops Room. (10) Twin 40 mm. Bofors guns. (11) Hinged whip aerials. (12) Single Bofors guns. (13) Twin Bofors guns. (14) Single Bofors guns on after Gun Platform. (15) Six-barrelled Bofors guns. (16) Motor launch (left) and fast 35 ft. motorboat (right). (17) Boiler uptakes. (18) Forward boiler room. (19) Forward engine room. (20) After boiler room. (21) After engine room. (22) Engineers' workshop. (23) Diesel generator rooms. (24) Fuel tanks. (25) Fuel working space. (26) Tiller flat. (27) Starboard rudder. (28) Admiral's dining room. (29) Admiral's suite. (30) Officers' cabins. (31) Quarter deck. (32) Wardrooms. (33) W/T office. (34) Inflatable life-rafts. (35) Officers' cabins. (36) Air Department's mess. (37) Seamen's mess. (38) Officers' bathrooms. (39) Mess Rooms for Marines, Stokers, E.R.A.s, etc. (40) Crew's washplaces and bathrooms. (41) Stores. (42) Fan flat. (43) Stores, etc. (44) Hose stowage platform. (45) Captain's sea cabin. (46) Laundry.



## TWO ENGINES IN ONE - AN ARTICULATED LOCOMOTIVE

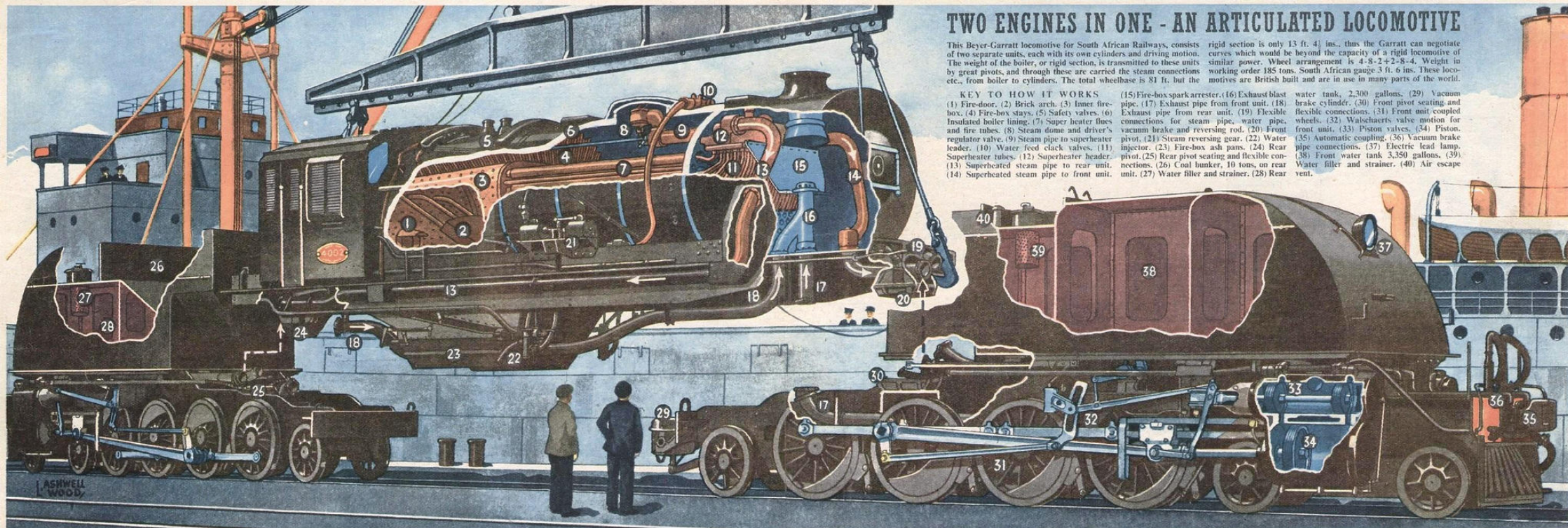
This Beyer-Garratt locomotive for South African Railways, consists of two separate units, each with its own cylinders and driving motion. The weight of the boiler, or rigid section, is transmitted to these units by great pivots, and through these are carried the steam connections etc., from boiler to cylinders. The total wheelbase is 81 ft, but the

rigid section is only 13 ft. 4½ ins., thus the Garratt can negotiate curves which would be beyond the capacity of a rigid locomotive of similar power. Wheel arrangement is 4-8-2+2-8-4. Weight in working order 185 tons. South African gauge 3 ft. 6 ins. These locomotives are British built and are in use in many parts of the world.

### KEY TO HOW IT WORKS

(1) Fire-door. (2) Brick arch. (3) Inner fire-box. (4) Fire-box stays. (5) Safety valves. (6) Insulated boiler lining. (7) Super heater flues and fire tubes. (8) Steam dome and driver's regulator valve. (9) Steam pipe to superheater leader. (10) Water feed clack valves. (11) Superheater tubes. (12) Superheater header. (13) Superheated steam pipe to rear unit. (14) Superheated steam pipe to front unit. (15) Fire-box spark arrester. (16) Exhaust blast pipe. (17) Exhaust pipe from front unit. (18) Exhaust pipe from rear unit. (19) Flexible connections for steam pipe, water pipe, vacuum brake and reversing rod. (20) Front pivot. (21) Steam reversing gear. (22) Water injector. (23) Fire-box ash pans. (24) Rear pivot. (25) Rear pivot seating and flexible connections. (26) Coal bunker, 10 tons, on rear unit. (27) Water filler and strainer. (28) Rear

(15) Fire-box spark arrester. (16) Exhaust blast pipe. (17) Exhaust pipe from front unit. (18) Exhaust pipe from rear unit. (19) Flexible connections for steam pipe, water pipe, vacuum brake and reversing rod. (20) Front pivot. (21) Steam reversing gear. (22) Water injector. (23) Fire-box ash pans. (24) Rear pivot. (25) Rear pivot seating and flexible connections. (26) Coal bunker, 10 tons, on rear unit. (27) Water filler and strainer. (28) Rear water tank, 2,300 gallons. (29) Vacuum brake cylinder. (30) Front pivot seating and flexible connections. (31) Front unit coupled wheels. (32) Walschaerts valve motion for front unit. (33) Piston valves. (34) Piston. (35) Automatic coupling. (36) Vacuum brake pipe connections. (37) Electric lead lamp. (38) Front water tank 3,350 gallons. (39) Water filler and strainer. (40) Air escape vent.





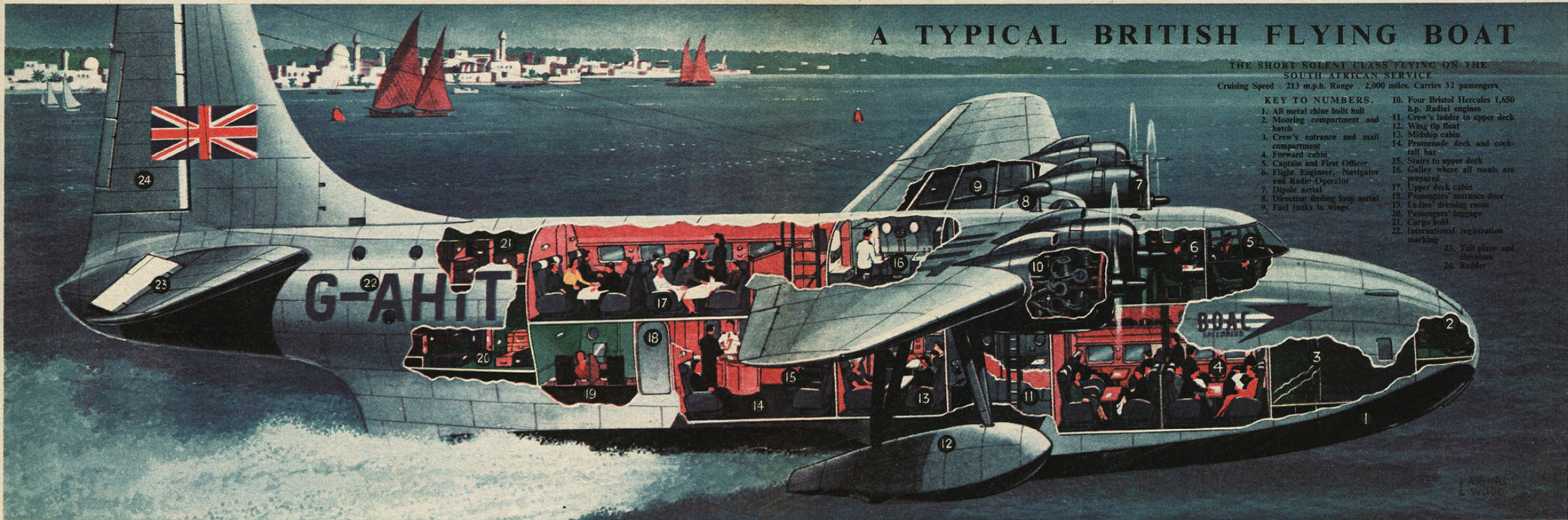
# A TYPICAL BRITISH FLYING BOAT

THE SHORT SOLENT CLASS FLYING ON THE  
SOUTH AFRICAN SERVICE

Cruising Speed . 213 m.p.h. Range . 2,000 miles. Carries 32 passengers

## KEY TO NUMBERS.

1. All metal chine built hull
2. Mooring compartment and hatch
3. Crew's entrance and mail compartment
4. Forward cabin
5. Captain and First Officer
6. Flight Engineer, Navigator and Radio Operator
7. Dipole aerial
8. Direction finding loop aerial
9. Fuel tanks in wings
10. Four Bristol Hercules 1,650 h.p. Radial engines
11. Crew's ladder to upper deck
12. Wing tip float
13. Midship cabin
14. Promenade deck and cocktail bar
15. Stairs to upper deck
16. Galley where all meals are prepared
17. Upper deck cabin
18. Passengers' entrance door
19. Ladies' dressing room
20. Passengers' luggage
21. Cargo hold
22. International registration marking
23. Tail plane and elevators
24. Rudder



L. WOOD



# THE STRATOCRUISER SPEEDBIRD

A 340 m.p.h. DOUBLE-DECK LUXURY AIR LINER  
FOR B.O.A.C.'s TRANSATLANTIC SERVICE.

## KEY TO NUMBERS.

1. Captain. 2. Co-pilot. 3. Forward landing wheels (retracted) 4. Crew's toilet.
5. Flight Engineer. 6. Radio Operator. 7. Navigator. 8. Forward cabin (8 seats).
9. Pressurised double skin for air conditioning in high altitudes. 10. Men's dressing room.
11. Ladies' dressing room. 12. Forward cargo hold. 13. Four 3,500 h.p. "Wasp Major" radial engines.
14. Fuel tanks in wings, total capacity 7,600 gallons. 15. Starboard landing wheels (retracted).
16. 'Midship cabin (24 seats). 17. Lounge and snack bar.
18. Food lift. 19. Pantry. 20. Spiral staircase. 21. Toilet. 22. Hats and coats.
23. Diplomatic mail. 24. Aft cargo hold. 25. Aft cabin (28 seats). 26. Stewards' station.



section of the thick wing, newly essential for aircraft, was soon to make its appearance also on flatirons, paperweights, and tombstones. The age of streamlining had arrived.

"... things which are too wonderful for me, yea . . . which I know not: the way of an eagle in the air . . ." —PROVERBS, XXX, 18, 19

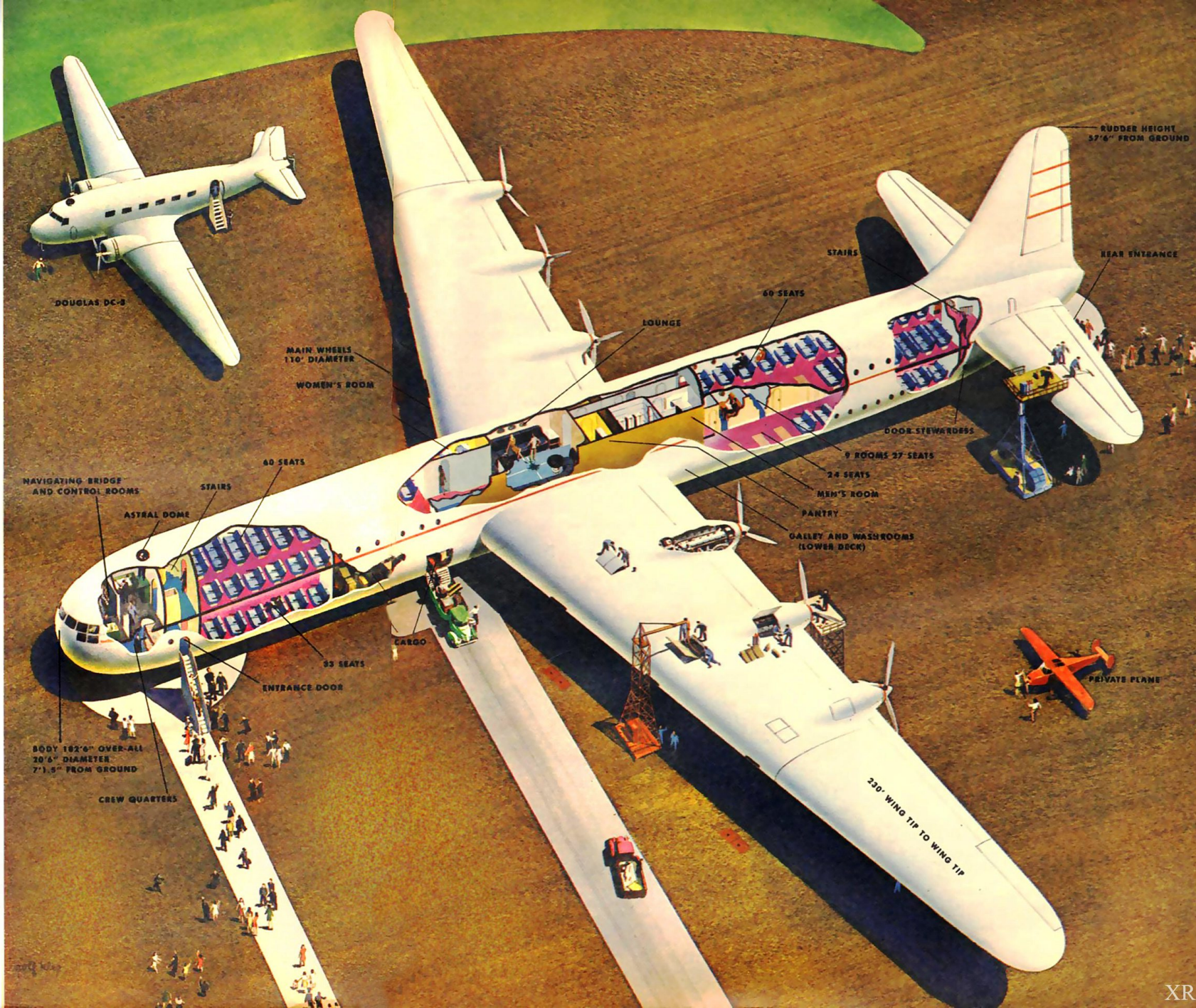
But it had very partially and imperfectly arrived. It would be fruitless to trace back to the inquisitive soul who first shied a pie plate through the air and tried to measure the interactions of the air and the airfoil. But although these measurements were now being gathered and systematized to some degree the known facts made a pitiful little pile compared to the vast bulk of the unknown. The very question of where to put the engines of a two-, three-, or four-motored ship had no scientific answer even in 1930, and as a result they were usually put in what later turned out to be the worst possible place; both the Ford and Fokker planes, in hanging the engines well below the wing, thereby achieved almost the greatest air resistance possible.

Thanks to that powerful instrumentality of research, the wind tunnel, the accumulated aerodynamic knowledge of the last fifteen years is probably a dozen times greater than from 1930 all the way to the days of King Solomon. Accordingly, by 1930 commercial aircraft—and indeed all others—were on the brink of an enormous step forward. The step is still visible, and totally taken for granted, on any commercial airplane flying today. To the eye, it is no more than a metal shape: the sheathing that surrounds the engine. This huge advance, the "total enclosure" cowl, was the product of the first wind tunnel in the U.S. large enough to take a full-scale engine and propeller: the Langley Field Wind Tunnel of the National Advisory Committee for Aeronautics (NACA), in which the brilliant engineer, Fred E. Weick, worked until he had produced the dual results of cooling the engine better than it had ever been cooled before and reducing by 50 per cent, because of the cowl's aerodynamic shape, the amount of drag the engines had previously contributed to the airplane's flight.

As if this aerodynamic improvement were not enough, Mr. Weick's researches also led straight to the knowledge that put the engines where nobody, lacking the new cowl, had been able to put them before: spanned on the line of the wing chord. When the Douglas DC-2 appeared in 1934, it was the first visible beneficiary of the NACA cowl and Mr. Weick's indefatigable researches. The Boeing 247, which had been using the best thing up to then, the "Townend Ring," followed along with the cowl a year later. These great new ships of the 1930's, which ushered in a new conception of transport flight, could scarcely have existed except for it—and for the fact behind it that the trial-and-error research of individual companies was now supplemented by a national research program for all to draw from, backed by the reserves of the U.S. Government and

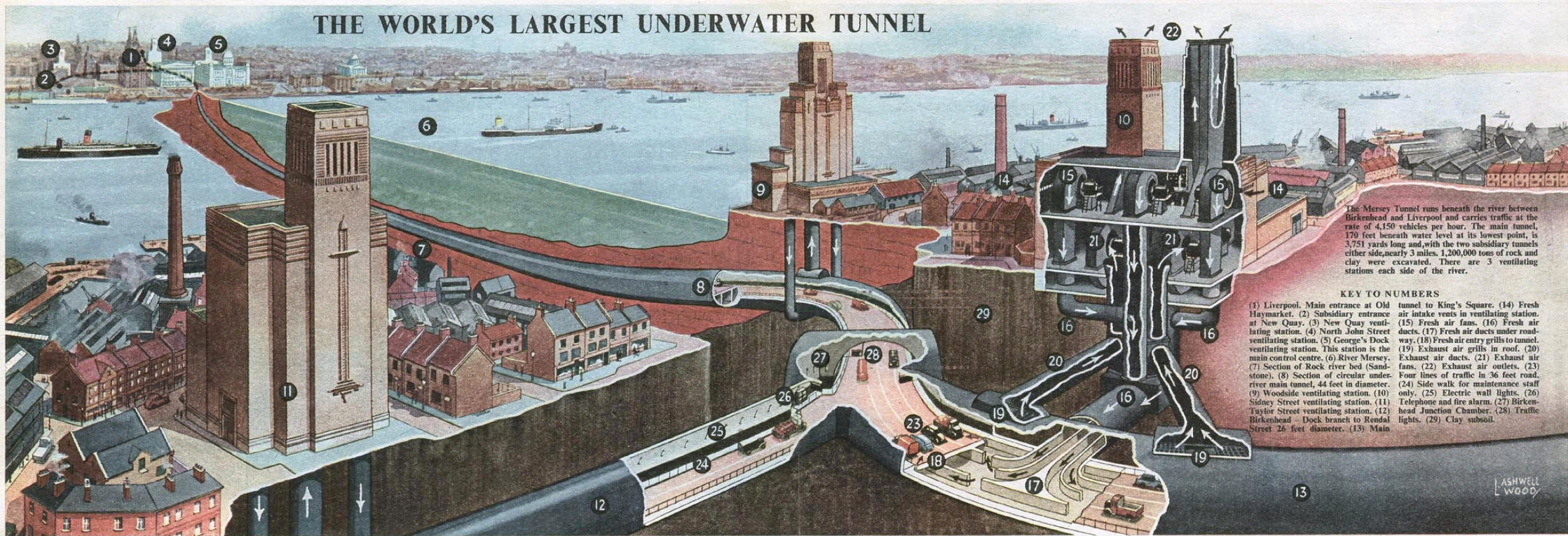
[Continued on page 258]

THIS IS CONSOLIDATED VULTEE'S CLIPPER, of which it may build as many as fifteen for Pan American's postwar transatlantic routes. It will weigh 160 tons and whisk 200 daytime passengers from New York to London in nine hours. It exists now in mockup form, will probably be test-flown eighteen months after V-E day. Pan American estimates that eleven of these planes could handle 440,000 passengers annually over the Atlantic runs, operating at only 50 per cent load factor. (You might put even money on a wager that the pusher props shown in this drawing, made from Consolidated's plans, will be tractor props again by the time the ship is finished.)



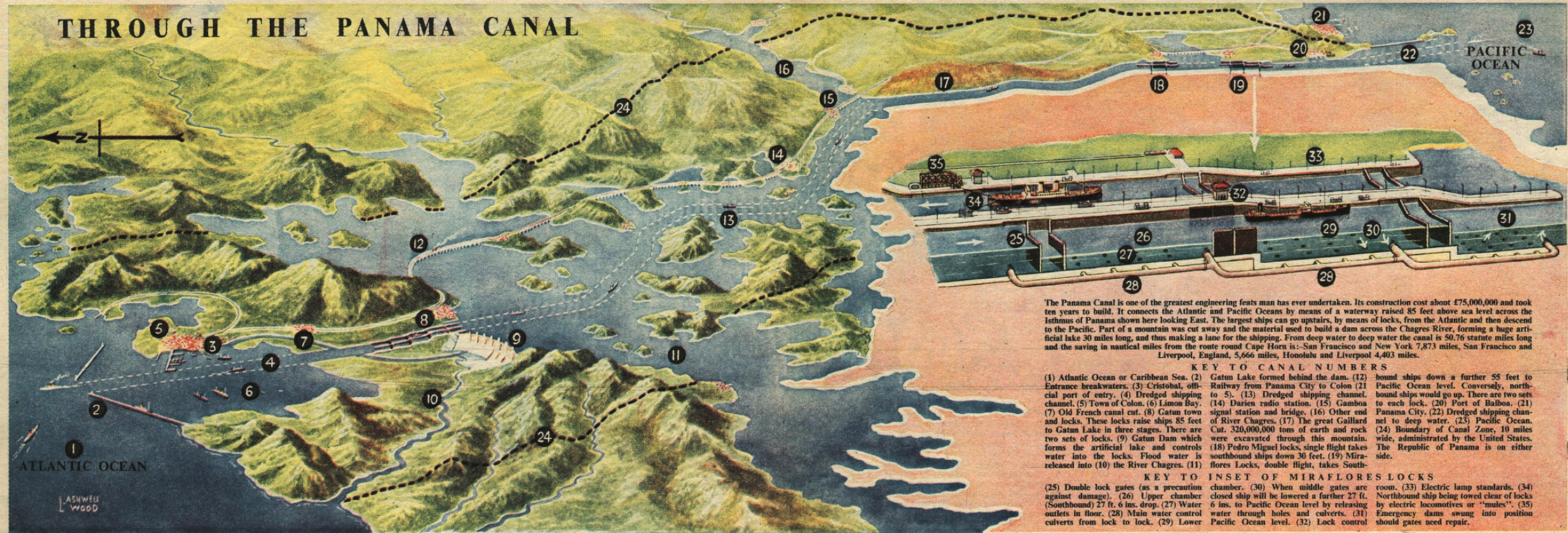


# THE WORLD'S LARGEST UNDERWATER TUNNEL





# THROUGH THE PANAMA CANAL



The Panama Canal is one of the greatest engineering feats man has ever undertaken. Its construction cost about \$75,000,000 and took ten years to build. It connects the Atlantic and Pacific Oceans by means of a waterway raised 85 feet above sea level across the Isthmus of Panama shown here looking East. The largest ships can go upstairs, by means of locks, from the Atlantic and then descend to the Pacific. Part of a mountain was cut away and the material used to build a dam across the Chagres River, forming a huge artificial lake 30 miles long, and thus making a lane for the shipping. From deep water to deep water the canal is 50.76 statute miles long and the saving in nautical miles from the route round Cape Horn is: San Francisco and New York 7,873 miles, San Francisco and Liverpool, England, 5,666 miles, Honolulu and Liverpool 4,403 miles.

## KEY TO CANAL NUMBERS

(1) Atlantic Ocean or Caribbean Sea. (2) Entrance breakwaters. (3) Cristobal, official port of entry. (4) Dredged shipping channel. (5) Town of Colon. (6) Limon Bay. (7) Old French canal cut. (8) Gatun town and locks. These locks raise ships 85 feet to Gatun Lake in three stages. There are two sets of locks. (9) Gatun Dam which forms the artificial lake and controls water into the locks. Flood water is released into (10) the River Chagres. (11) Gatun Lake formed behind the dam. (12) Railway from Panama City to Colon (21 to 5). (13) Dredged shipping channel. (14) Darien radio station. (15) Gamboa signal station and bridge. (16) Other end of River Chagres. (17) The great Gaillard Cut. 320,000,000 tons of earth and rock were excavated through this mountain. (18) Pedro Miguel locks, single flight takes southbound ships down 30 feet. (19) Miraflores Locks, double flight, takes South-

bound ships down a further 55 feet to Pacific Ocean level. Conversely, northbound ships would go up. There are two sets to each lock. (20) Port of Balboa. (21) Panama City. (22) Dredged shipping channel to deep water. (23) Pacific Ocean. (24) Boundary of Canal Zone, 10 miles wide, administered by the United States. The Republic of Panama is on either side.

## KEY TO INSET OF MIRAFLORES LOCKS

(25) Double lock gates (as a precaution against damage). (26) Upper chamber (Southbound) 27 ft. 6 ins. drop. (27) Water outlets in floor. (28) Main water control culverts from lock to lock. (29) Lower chamber. (30) When middle gates are closed ship will be lowered a further 27 ft. 6 ins. to Pacific Ocean level by releasing water through holes and culverts. (31) Pacific Ocean level. (32) Lock control room. (33) Electric lamp standards. (34) Northbound ship being towed clear of locks by electric locomotives or "mules". (35) Emergency dams swung into position should gates need repair.



RYAN V.Z.11

# TWO-WAY

jet

In December, 1961, the Ryan Aeronautical Company were awarded a sub-contract for the design and construction of two fan-in-the-wing V.T.O.L. (vertical take off and landing) aircraft. The first prototype of the plane, known as the Ryan V.Z.11, flew early this year. Ryan have teamed up with General Electric to produce these machines.

Basically, the aircraft has two jet engines facing rearward, these operate in the normal way for forward flight. When the pilot wants to land, he slows the machine down by using the throttles, lowering the wheels and flaps, and then, at a height of 100 ft and a speed of 150 kts., the inlet and exit louvres are opened by the diverter valve, and the thrust is increased to maintain height. At this point, the pilot can land it vertically like a helicopter. Taking off is virtually the reverse of this process. The pilot has a lift lever at his left hand which he slowly raises to the vertical position. This has the effect of turning the exit louvres to a vertical position. As soon as the thrust exceeds the weight, the plane takes off. Roll control is governed by the control column which, by sideways movement of the stick, partially opens or closes these louvres. Control is maintained by the rudder pedals reflecting the louvres forwards beneath one wing and rearwards beneath the other. For forward movement, the pilot moves a thumb wheel on the stick, which moves the louvres to the rear to drive the aircraft forwards. The undercarriage is retracted and as the machine reaches 120 kts with exit louvres fully deflected, the diverter valves are actuated and the inlet and exit doors shut.

The aircraft is fairly conventional in construction. The lift fans are accommodated in a two-spar wing which has flaps and ailerons. The nose fan is situated just forward of the cockpit which is of the large bubble type giving excellent visibility. Both crewmen have ejection seats. The engines are mounted above the fuselage, the tailpipes exhausting beneath the rear of the wing. The tailplane and elevator are mounted 'T' fashion on top of the fin. The plane has a tricycle undercarriage.

## KEY TO NUMBERED PARTS

(1) Nose pitot. (2) Nose-fan—300-lb thrust. (3) Nose-fan reverser doors. (4) Nose-fan inlet louvres. (5) Nose-fan supply duct. (6) Nose wheel. (7) Control column. (8) Pilot's position, port side. (9) 'Zero zero' ejector seats. (10) Radio and electronic compartment. (11) Air-intake. (12) Fan doors in closed position. (13) Port aileron. (14) Port flap. (15) General Electric J.85-5 turbojet. (16) Diverter valve. (17) Exhaust duct to fan. (18) Rear duct to fan. (19) Fuel tank. (20) Fan doors. (21) Lift fan. (22) Main undercarriage. (23) Front spar. (24) Rear spar. (25) Ailerons. (26) Flap. (27) Undercarriage doors. (28) Tailpipe. (29) Fuel tanks. (30) Deflector plates. (31) Dorsal fin. (32) Fin. (33) Rudder. (34) Tailplane. (35) Elevator. (36) Rear spar. (37) Main spar.

## TECHNICAL DATA

|               |                                                          |
|---------------|----------------------------------------------------------|
| Power Plants  | Two General Electric J.85-5 turbojets of 2,658 lb thrust |
| Span          | 29 ft 10 ins                                             |
| Length        | 44 ft 6 ins                                              |
| Height        | 15 ft 7 ins                                              |
| Weight        | Empty, 7,054 lb<br>Fully laden, 13,600 lb                |
| Maximum Speed | Mach 0.83 at 2,500 ft                                    |
| Range         | 1,810 nautical miles                                     |



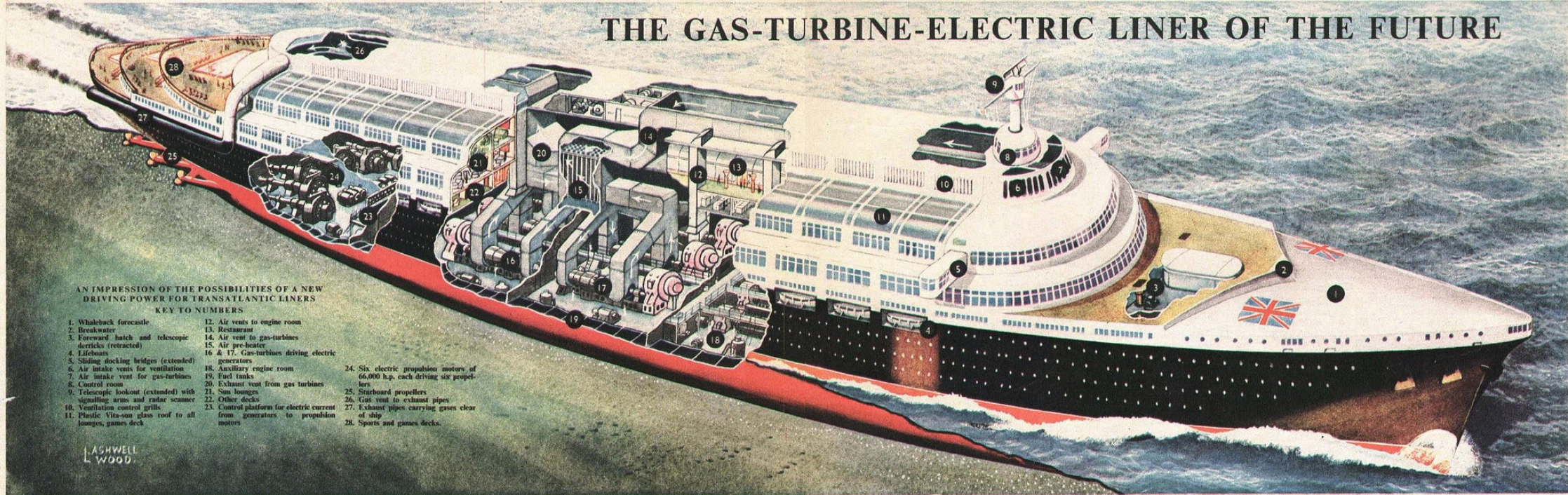


# THE GAS-TURBINE-ELECTRIC LINER OF THE FUTURE

AN IMPRESSION OF THE POSSIBILITIES OF A NEW  
DRIVING POWER FOR TRANSATLANTIC LINERS

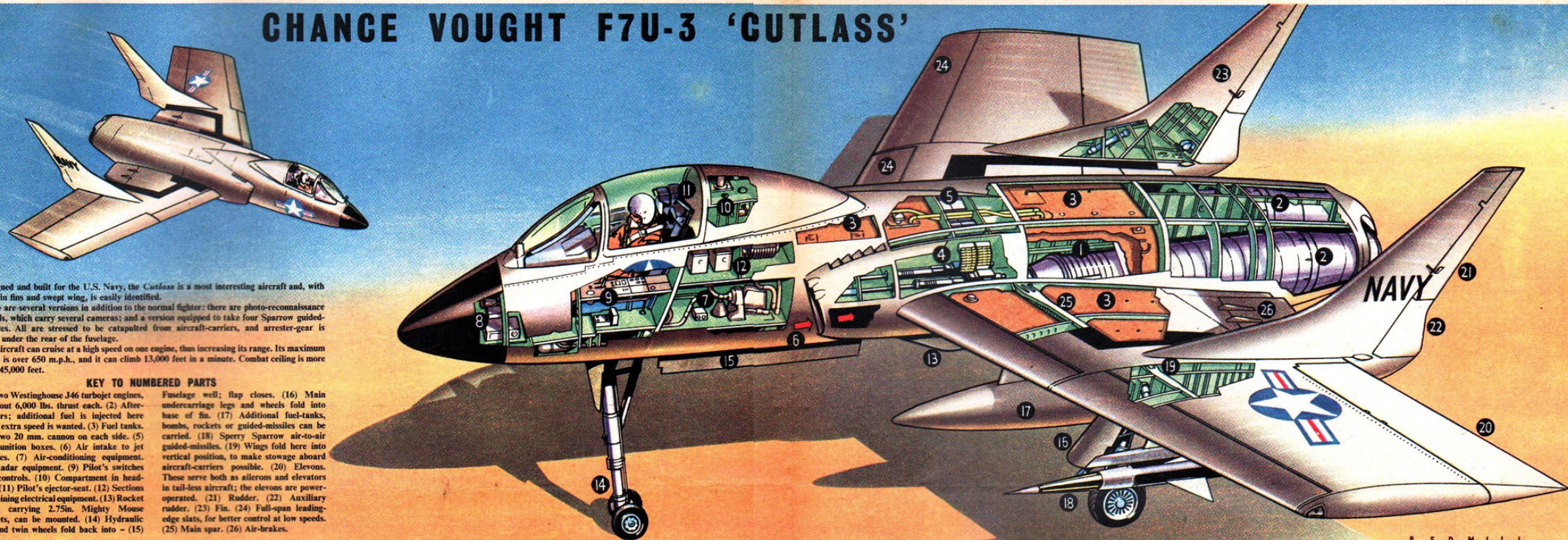
- KEY TO NUMBERS
- |                                                                         |                                                                                |                                                                               |
|-------------------------------------------------------------------------|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| 1. Whaleback forecastle                                                 | 12. Air vents to engine room                                                   | 24. Six electric propulsion motors of 66,000 h.p. each driving six propellers |
| 2. Breakwater                                                           | 13. Restaurant                                                                 | 25. Starboard propellers                                                      |
| 3. Foreward hatch and telescopic derricks (retracted)                   | 14. Air vent to gas-turbines                                                   | 26. Gas vent to exhaust pipes                                                 |
| 4. Lifeboats                                                            | 15. Air pre-heater                                                             | 27. Exhaust pipes carrying gases clear of ship                                |
| 5. Sliding docking bridges (extended)                                   | 16 & 17. Gas-turbines driving electric generators                              | 28. Sports and games decks                                                    |
| 6. Air intake vents for ventilation                                     | 18. Auxiliary engine room                                                      |                                                                               |
| 7. Air intake vent for gas-turbines                                     | 19. Fuel tanks                                                                 |                                                                               |
| 8. Control room                                                         | 20. Exhaust vent from gas turbines                                             |                                                                               |
| 9. Telescopic lookout (extended) with signalling arms and radar scanner | 21. Sun lounges                                                                |                                                                               |
| 10. Ventilation control grills                                          | 22. Other decks                                                                |                                                                               |
| 11. Plastic Vita-sun glass roof to all lounges, games deck              | 23. Control platform for electric current from generators to propulsion motors |                                                                               |

LASHWELL  
WOOD





# CHANCE VOUGHT F7U-3 'CUTLASS'



Designed and built for the U.S. Navy, the *Cutlass* is a most interesting aircraft and, with its twin fins and swept wing, is easily identified.

There are several versions in addition to the normal fighter; there are photo-reconnaissance models, which carry several cameras; and a version equipped to take four Sparrow guided-missiles. All are stressed to be catapulted from aircraft-carriers, and arrestor-gear is fitted under the rear of the fuselage.

The aircraft can cruise at a high speed on one engine, thus increasing its range. Its maximum speed is over 650 m.p.h., and it can climb 13,000 feet in a minute. Combat ceiling is more than 45,000 feet.

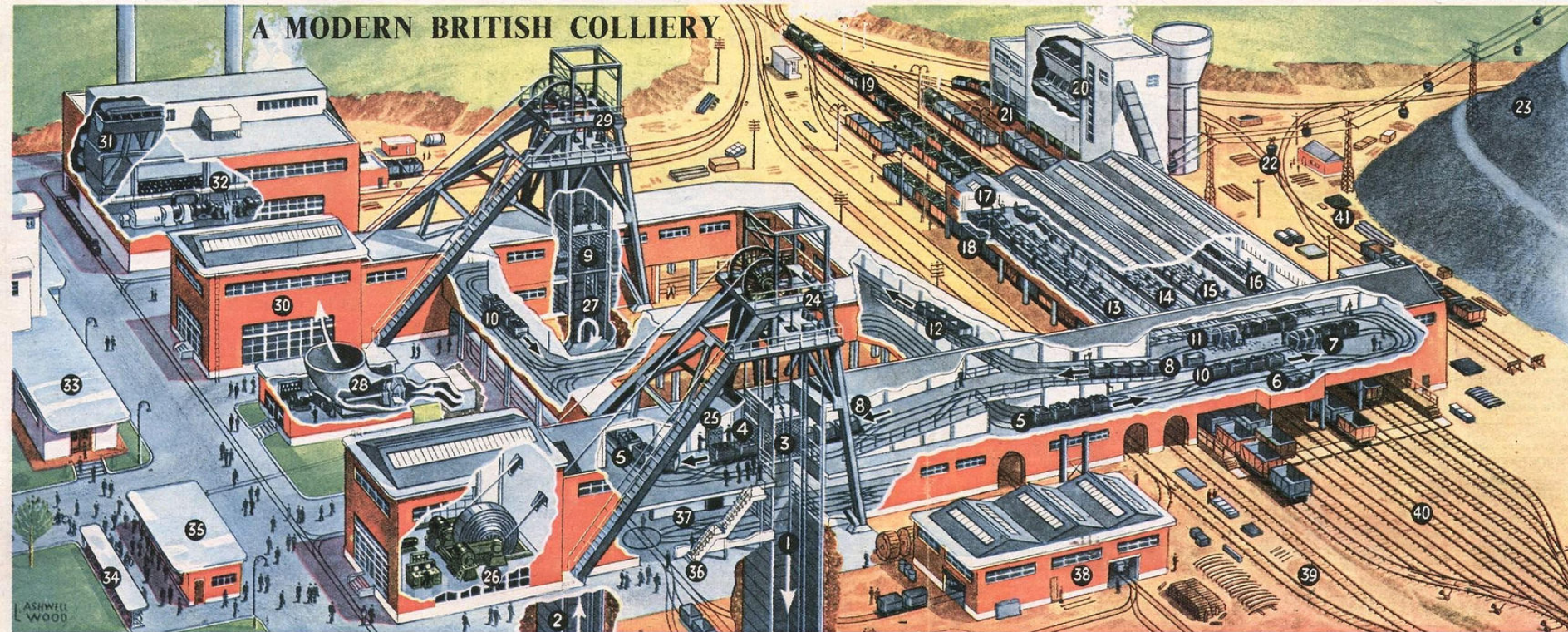
## KEY TO NUMBERED PARTS

(1) Two Westinghouse J46 turbojet engines, of about 6,000 lbs. thrust each. (2) After-burners; additional fuel is injected here when extra speed is wanted. (3) Fuel tanks. (4) Two 20 mm. cannon on each side. (5) Ammunition boxes. (6) Air intake to jet engines. (7) Air-conditioning equipment. (8) Radar equipment. (9) Pilot's switches and controls. (10) Compartment in head-rest. (11) Pilot's ejector-seat. (12) Sections containing electrical equipment. (13) Rocket pack, carrying 2.75in. Mighty Mouse rockets, can be mounted. (14) Hydraulic leg and twin wheels fold back into - (15)

Fuselage well; flap closes. (16) Main undercarriage legs and wheels fold into base of fin. (17) Additional fuel-tanks, bombs, rockets or guided-missiles can be carried. (18) Sperry Sparrow air-to-air guided-missiles. (19) Wings fold here into vertical position, to make stowage aboard aircraft-carriers possible. (20) Elevons. These serve both as ailerons and elevators in tail-less aircraft; the elevons are power-operated. (21) Rudder. (22) Auxiliary rudder. (23) Fin. (24) Full-span leading-edge slats, for better control at low speeds. (25) Main spar. (26) Air-brakes.



# A MODERN BRITISH COLLIERY



For millions of years the coal which we burn has been embedded in the earth's crust, and the methods of winning this coal have been subject to continual experiment and research by mining engineers.

A modern colliery is planned to ensure the minimum waste of time and labour. The illustration shows a typical example of a modern coal mine at the surface. Several such mines have been built in Great Britain.

In next week's issue of EAGLE we shall continue the story below ground, showing the actual winning of the coal.

## KEY TO THE PROGRESSIVE OPERATIONS AT PIT HEAD

(1) Downcast shaft. (2) Upcast shaft (these relate to the air supply; the cages go up and down in both). (3) Cage raised. (4) Full tubs, or "trams" as they are called, pushed out by empty tubs the other side. (5) Full tubs gravitate to screens by a slight fall in level. (6) Weighbridge. (7) Tippler which turns the full tubs upside down. The coal, falling on to screens which have holes of several sizes like a huge sieve, is graded into four sizes - Large, Cobbles, Nuts and Smalls. (8) Empty tubs returned to cage (hauled up slopes by cable). (9) Cage raised. (10) Full tubs to screens. (11) Tippler. (12) Empty tubs returned to cage. (13) Large coal conveyor belt from screens. On this, and the two following belts, stone, slate etc. is picked out. (14) Cobbles conveyor. (15) Nuts conveyor. (16) Smalls conveyor. This coal being too small to be picked is passed on to the washery. (17) Conveyor jib to hopper. (18) Wagon being filled from hopper. As each wagon is filled the wagon man moves another forward down the slight incline of the sidings. (19) Graded coal train despatched to destination. (20) Smalls washery. Here the shale, stone etc. sinks to the bottom of the machine. (21) Washed smalls hopper to wagons. (22) Stone waste etc. from picking belts, conveyed to slag heap. (23) Slag heap.

## KEY TO OTHER PARTS

(24) Downcast shaft head gear. (25) Banksman in charge of cages. (26) Conical winding drum and electric motors with winding control desk. The cages counterbalance each other, one ascending while the other descends. (27) Air ventilating tunnel from upcast shaft. There is an air lock either side of the cage openings of this shaft. (28) Fan house. A huge electric fan draws bad air from the mine. (29) Upcast shaft head gear. (30) Upcast shaft winding house. (31) Boiler house. (32) Power house with air compressors and pumps. Turbo-generators supply electricity to the whole coal mine. (33) Pithead baths and canteen. Each man has a locker for his mining clothes; he can then have a shower and don his ordinary clothes from another locker. (34) Cycle store. (35) Lamp room and First Aid. Each man collects an electric lamp going on duty. They are re-charged between shifts. (36) Entrance to pit. (37) Tub maintenance level. (38) Workshops. (39) Through sidings for stores etc. (40) Loading sidings. These have a slight fall of 1 in 72 to the hoppers. (41) Sidings for stores.

Next week - The story below ground



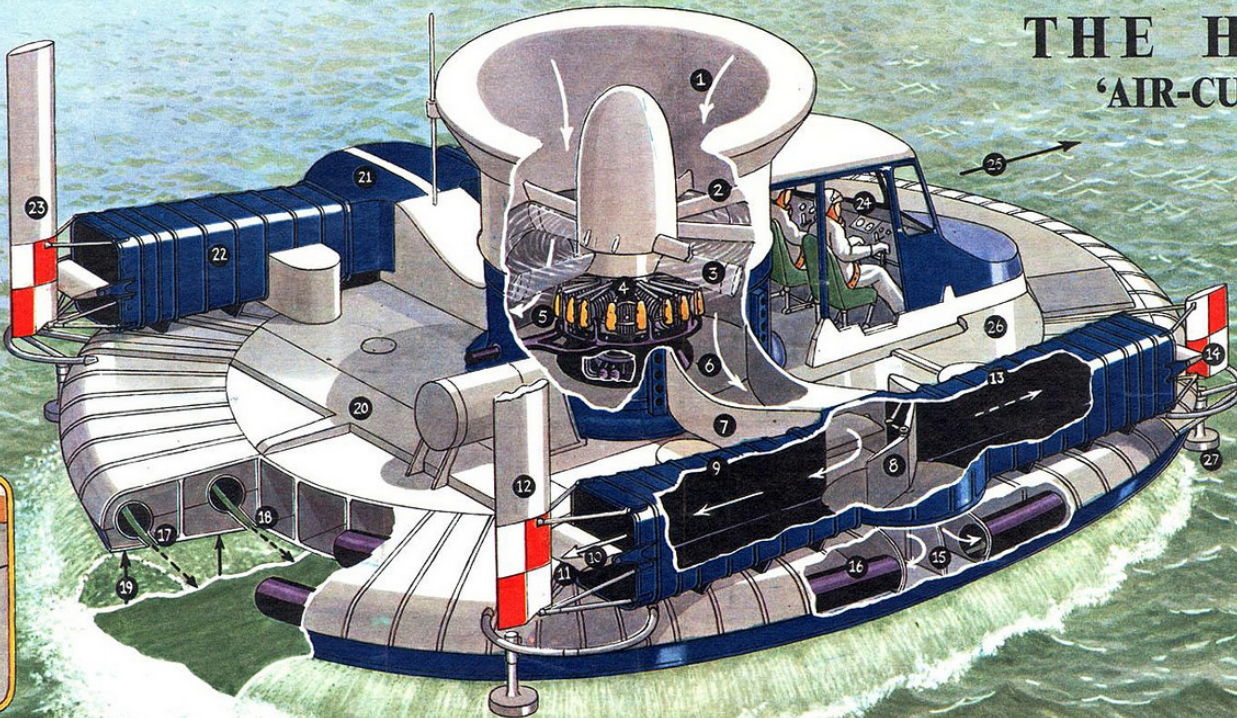
The incredible shape of things to come! Latest development is The Hovercraft which, supported on a 'cushion' of air, has made successful skims across the surface of the sea.

This unique British project, which may revolutionize transport by land, sea and air as we know it, is called the SR-N1, and has been constructed at the Saunders-Roe works at Cowes, Isle of Wight. It is 30 ft. long, 24 ft. wide and weighs some 3½ tons; forward speed is 25 knots; the operating height is about 15 ins. above sea or ground level. A 450 h.p. Alvis Leonides radial engine drives a ducted fan, which forces air through slits all round the base of the machine, giving it lift. The fan also forces air through ducts for forward and rearward propulsion.

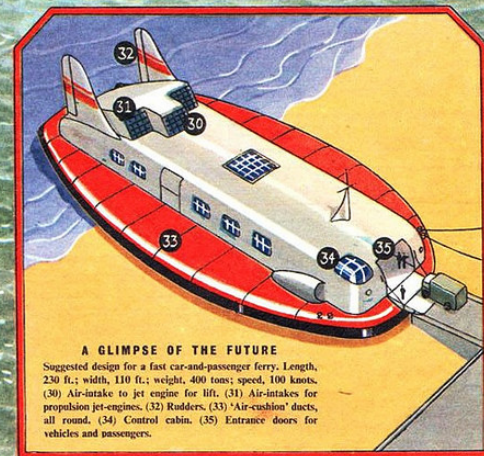
The future possibilities are enormous; perhaps a 100-ton ferry to take 300 passengers, or a 400-ton transport to lift 160 tons of vehicles. Hovercraft could be used over deserts, or frozen rivers and lakes.

### KEY TO HOW IT WORKS

(1) Main air-intake. (2) Guide vanes. (3) Four-bladed fan. This supplies air for lift and propulsion. (4) Alvis Leonides 450 h.p. nine-cylinder radial engine. (5) Air supply to lifting slits and port propulsion ducts. (6) Air supply to lifting slits and starboard propulsion ducts. (7) Narrow orifice increasing air pressure. (8) Main starboard propulsion valve. Shown greatly simplified, this directs the air for forward or rearward propulsion. (9) Starboard forward-propulsion duct. (10) Air-jet efflux. (11) Elevons, which act as ailerons or elevators. (12) Starboard rudder. (13) Starboard rearward-propulsion duct. (14) Rearward-propulsion elevon and rudder. (15) Main starboard air-valve for lift. (16) Outer air-pipeline for lift; all round base of machine. (17) Slits in base of machine, creating the 'air-cushion' (or air-curtain) for lift. (18) Slits for air-curtain stability control. (19) Direction of lift above sea-level. (20) Control runs. (21) Port propulsion valve-chamber. (22) Port forward-propulsion duct. (23) Port rudder. (24) Control cabin. (25) Direction of forward motion over the sea. (26) Control runs. (27) Landing legs when on land.

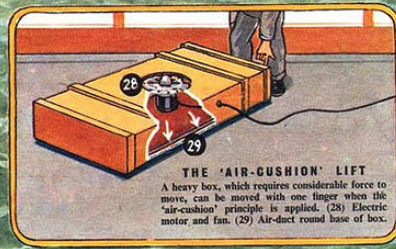


# THE HOVERCRAFT 'AIR-CUSHION' MACHINE



### A GLIMPSE OF THE FUTURE

Suggested design for a fast car-and-passenger ferry. Length, 230 ft.; width, 110 ft.; weight, 400 tons; speed, 100 knots. (30) Air-intake to jet engine for lift. (31) Air-intakes for propulsion jet-engines. (32) Rudders. (33) 'Air-cushion' ducts, all round. (34) Control cabin. (35) Entrance doors for vehicles and passengers.



### THE 'AIR-CUSHION' LIFT

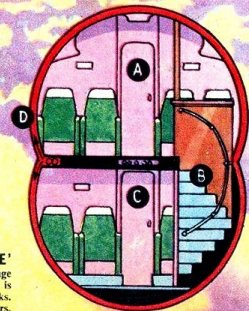
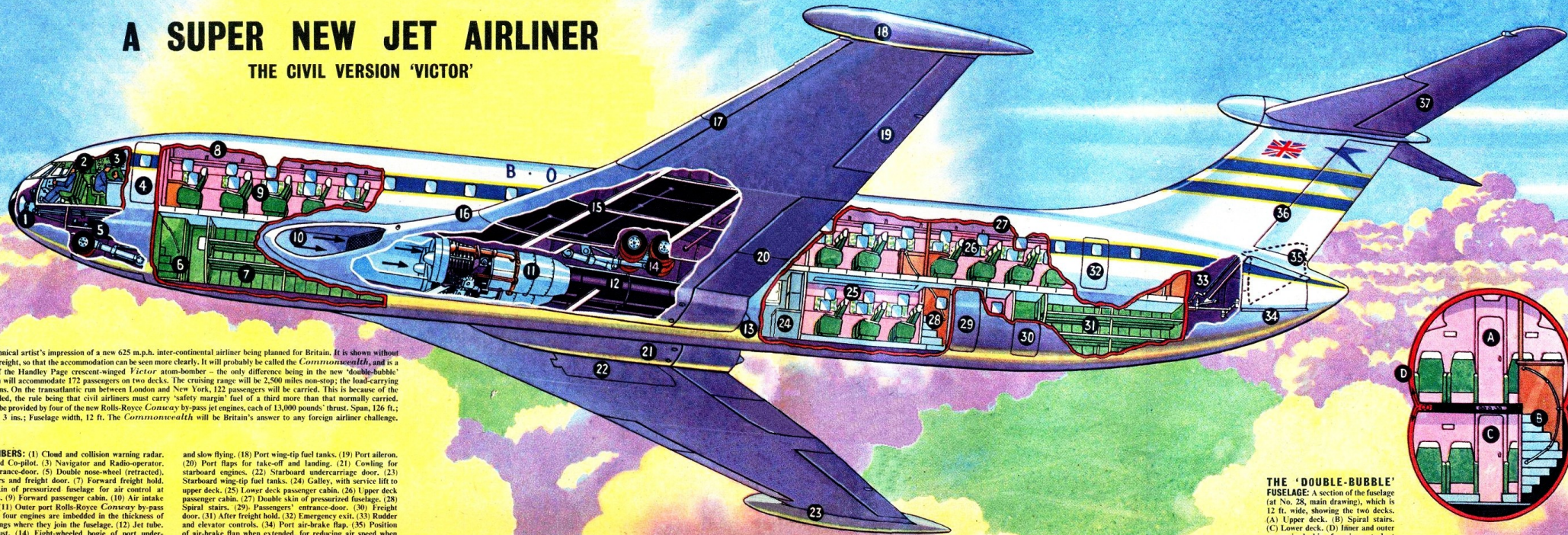
A heavy box, which requires considerable force to move, can be moved with one finger when the 'air-cushion' principle is applied. (28) Electric motor and fan. (29) Air-duct round base of box.

LASHWELL  
WOOD



# A SUPER NEW JET AIRLINER

THE CIVIL VERSION 'VICTOR'



**THE 'DOUBLE-BUBBLE'**  
FUSELAGE: A section of the fuselage (at No. 28, main drawing), which is 12 ft. wide, showing the two decks. (A) Upper deck. (B) Spiral stairs. (C) Lower deck. (D) Inner and outer pressurized skin, for air control at varying heights.

L. ASHVELL  
WOOD

This is our technical artist's impression of a new 625 m.p.h. inter-continental airliner being planned for Britain. It is shown without passengers or freight, so that the accommodation can be seen more clearly. It will probably be called the *Commonwealth*, and is a development of the Handley Page crescent-winged *Victor* atom-bomber – the only difference being in the new 'double-bubble' fuselage, which will accommodate 172 passengers on two decks. The cruising range will be 2,500 miles non-stop; the load-carrying capacity, 18 tons. On the transatlantic run between London and New York, 122 passengers will be carried. This is because of the extra fuel needed, the rule being that civil airliners must carry 'safety margin' fuel of a third more than that normally carried. The power will be provided by four of the new Rolls-Royce *Conquest* by-pass jet engines, each of 13,000 pounds' thrust. Span, 126 ft.; Length, 123 ft. 3 ins.; Fuselage width, 12 ft. The *Commonwealth* will be Britain's answer to any foreign airliner challenge.

**KEY TO NUMBERS:** (1) Cloud and collision warning radar. (2) Captain and Co-pilot. (3) Navigator and Radio-operator. (4) Crew's entrance-door. (5) Double nose-wheel (retracted). (6) Spiral stairs and freight door. (7) Forward freight hold. (8) Double skin of pressurized fuselage for air control at varying heights. (9) Forward passenger cabin. (10) Air intake to jet engines. (11) Outer port Rolls-Royce *Conquest* by-pass jet-engine. The four engines are imbedded in the thickness of the crescent wings where they join the fuselage. (12) Jet tube. (13) Jet exhaust. (14) Eight-wheeled bogie of port undercarriage (retracted). (15) Fuel tanks. (16) Swept-back crescent wing. (17) Two-piece nose-flaps on leading edge, for landing

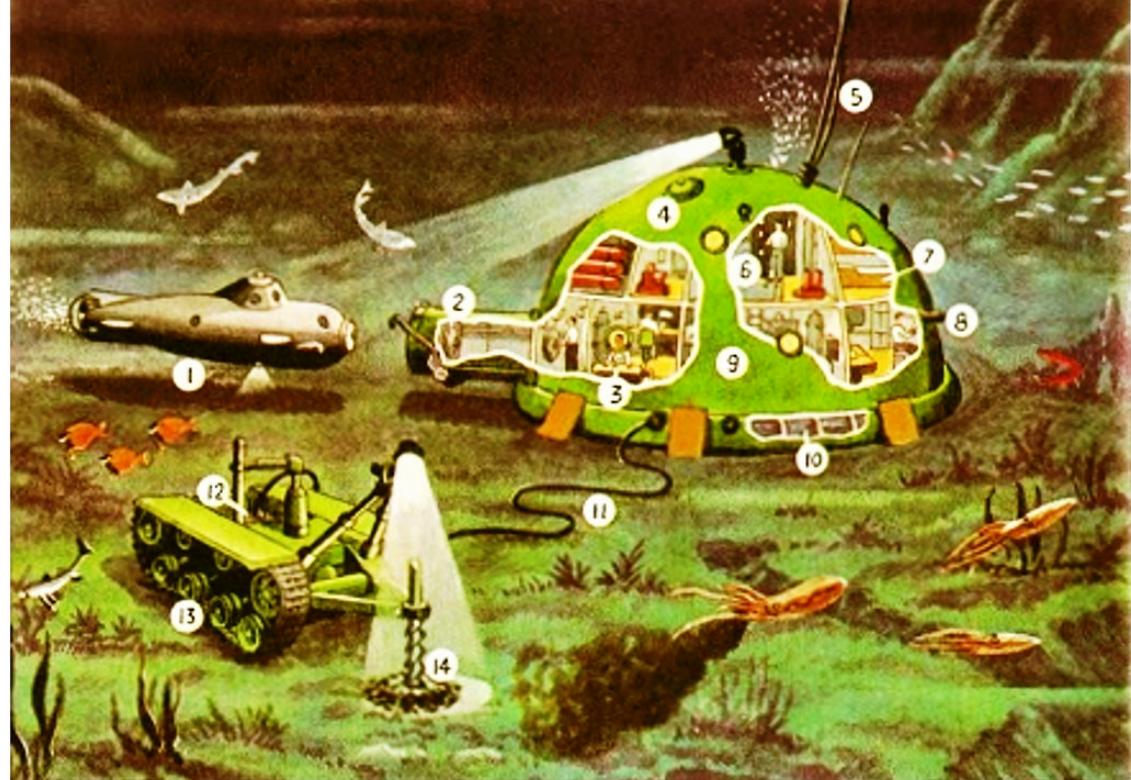
and slow flying. (18) Port wing-tip fuel tanks. (19) Port aileron. (20) Port flaps for take-off and landing. (21) Cowling for starboard engines. (22) Starboard undercarriage door. (23) Starboard wing-tip fuel tanks. (24) Galley, with service lift to upper deck. (25) Lower deck passenger cabin. (26) Upper deck passenger cabin. (27) Double skin of pressurized fuselage. (28) Spiral stairs. (29) Passengers' entrance-door. (30) Freight door. (31) After freight hold. (32) Emergency exit. (33) Rudder and elevator controls. (34) Port air-brake flap. (35) Position of air-brake flap when extended, for reducing air speed when landing. (36) Staggered fin and rudder. (37) Swept-back tail-plane and elevators.



## DRILLING THE OCEAN FLOOR

THE most exciting developments in Oceanography are yet to come — the almost inexhaustible mineral wealth in the ocean floor will be explored and made available. It is estimated that there is 100,000 million tons of oil in some of the ocean beds. There will be "cities" beneath the sea where men will live and work. The underwater houses of today are merely primitive forerunners of those that will be built. In this United States deep-sea mining exploration, men would work in the dome-shaped pressure-proof hull lowered to the sea bed, and control outside drilling and mining machines by means of electric cables in order to obtain samples of minerals in the ocean floor.

**KEY TO NUMBERED PARTS**  
(1) Mini-submarine for exchanging crews from surface ship. (2) Air-lock chamber. (3) Drilling tractor control cabinet. (4) Compressed air and oxygen cylinders. (5) Power and telephone cables from surface ship. (6) Air-regenerating machine for crew breathing. (7) Crew's rest-room. (8) Underwater television camera for studying marine life. (9) Steel pressure-proof hull. The whole structure and the tractor are lowered and raised by surface ships. (10) Water ballast tanks for stability on the sea bed. (11) Electric cables to drilling machine. (12) Watertight power motor. (13) Tractor guide wheels. (14) Mining drill for excavation of sea-bed minerals.



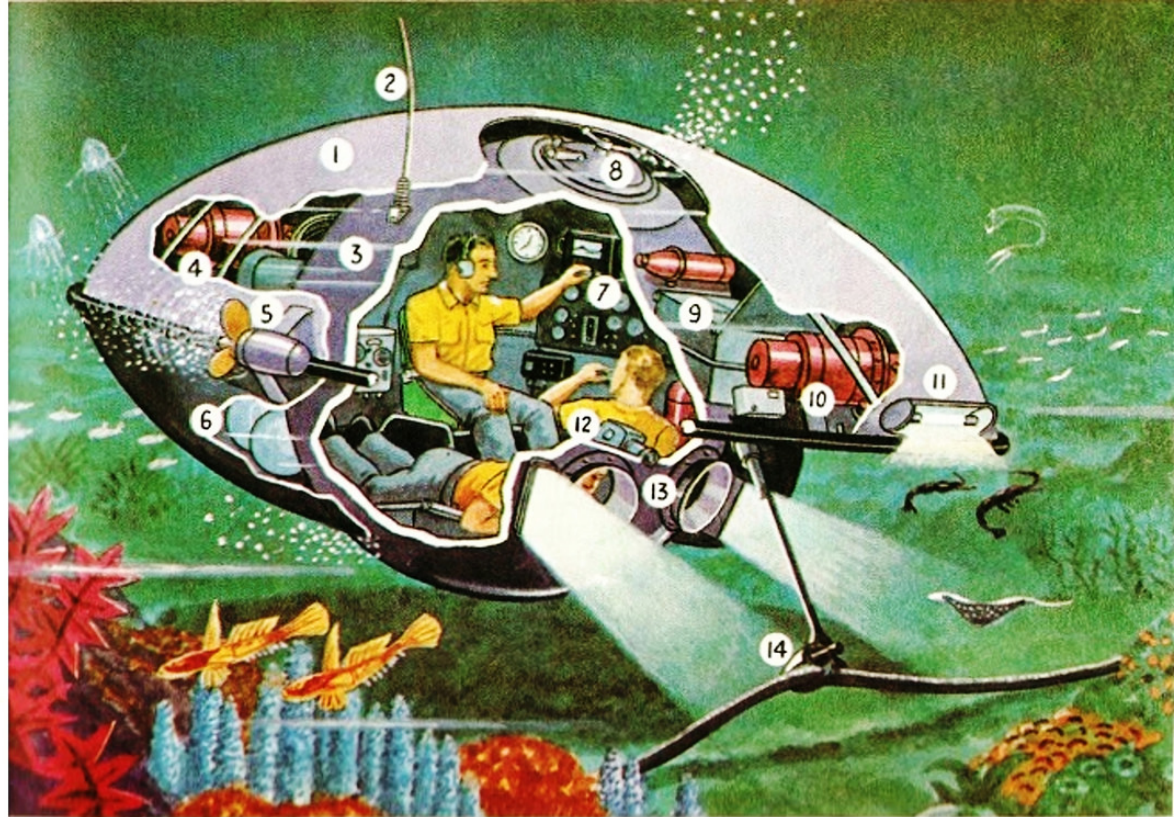
DEEP SEA MINING



## DEEP SEA "PRIVATE EYE"

WE have heard of "flying saucers" but now we actually have "diving saucers". There are two American-designed diving saucers for underwater observations — one a small "runabout" to carry two aquanauts down to a depth of 1,000 ft. and a larger one called Deepstar, shown here. This is an 8-ton search and rescue diving vessel of unique design; it carries three men and can dive to 4,000 ft. for about 24 hours' duration, cruising around at 3 knots by means of two outside propellers. Deepstars positioned around the world could go to the help of any submarine in a mishap, wherever it may be. The crew are inside a thick steel pressure-proof sphere with the surrounding saucer-shape structure free-flooding.

**KEY TO NUMBERED PARTS**  
(1) Fibreglass saucer structure. (2) Radio aerial. (3) Steel pressure-proof sphere, 6½ ft. in diameter. (4) Rear mercury cylinder for pitch control. (5) Starboard electric propulsion motor and propeller. (6) Water ballast spheres. (7) Instrument panel for depth indicator, direction gyroscope, two-way underwater telephone, etc. (8) Entrance hatch. (9) Batteries for power supply. (10) Front mercury cylinder — mercury is transferred between front and rear cylinders to control pitch of craft. (11) Floodlight for motion-picture camera work. (12) Motion-picture camera. (13) Viewing ports and floodlights. (14) Mechanical claw operated from inside the pressure sphere.



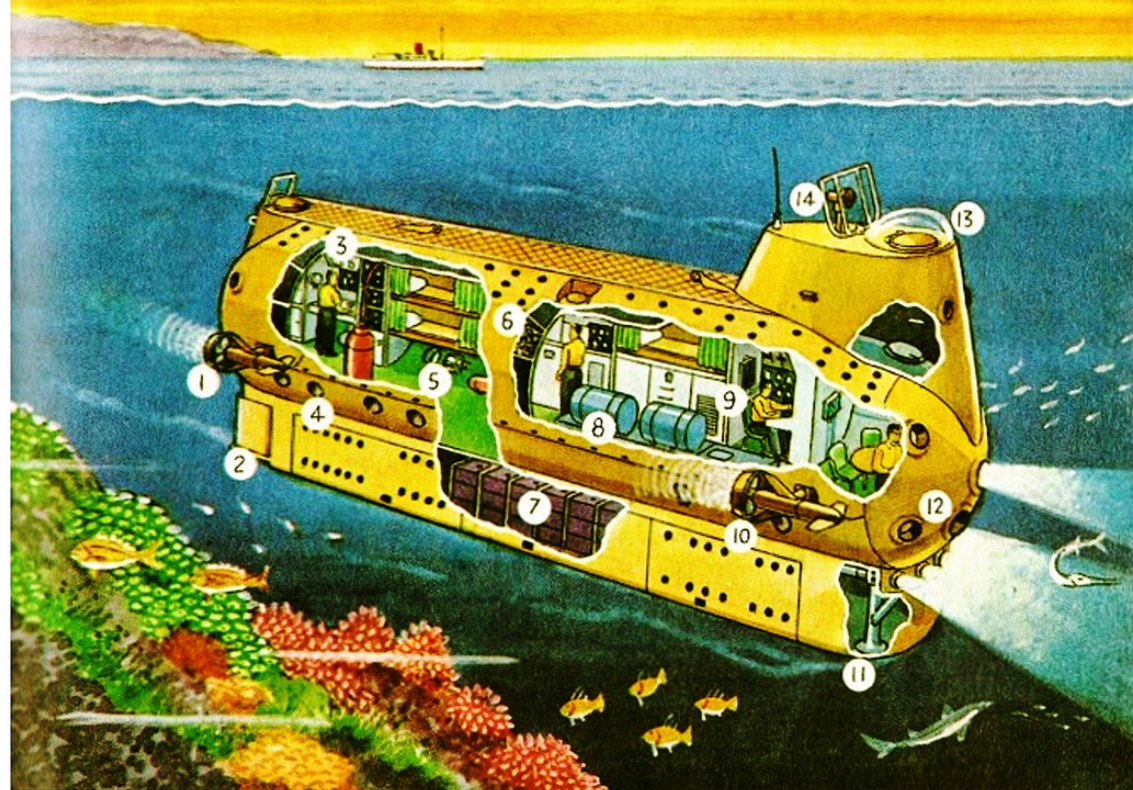
DEEPSTAR - DIVING SAUCER



# FOLLOWING THE GULF STREAM

SIX aquanauts will descend to 2,000 ft. off the Florida coast, U.S.A., in an underwater craft and drift for 1,500 miles with the Gulf Stream – the “river in the sea”, as it is called. The mini submarine Ben Franklin will hover and drift north-east in the Atlantic Ocean at an average speed of 2 knots; scientists will watch layers of plankton and the fish that live off them. Such information will be useful for the fishing industry and the eventual fish farming of the sea. Ben Franklin is 50 ft. long and weighs 130 tons; it is equipped with four electric motors and propellers to maintain position in the heart of the current. The craft takes its name from Benjamin Franklin, the American scientist who first charted the Gulf Stream.

KEY TO NUMBERED PARTS  
(1) Rear starboard propulsion motor. (2) Steering rudder. (3) Scientific control centre and laboratory. (4) Starboard viewing ports. (5) Cine camera, also inlet for fish plankton samples. (6) Iron shot – released in an emergency to bring craft to surface. (7) Storage batteries supply all electrical power. (8) Fresh-water tanks. (9) Operational control centre. (10) Forward starboard propulsion motor – all four 25 h.p. motors swivel for vertical or horizontal direction. (11) Support legs for craft when resting on sea bed. (12) Forward viewing ports and floodlights. (13) Entrance hatch and canopy for lookout when on surface. (14) Television camera and radio-telephone to following surface ship.



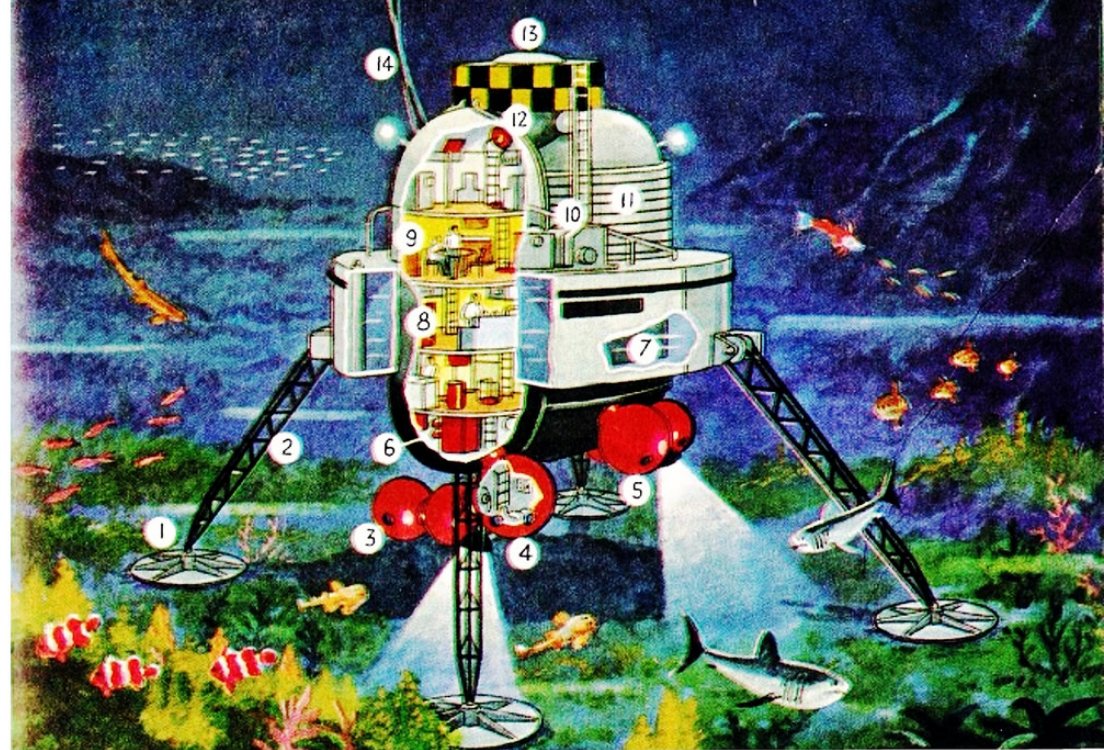
BEN FRANKLIN - SUBMARINE



# DEEP SEA RESEARCH STATION

WE have astronauts who go up to the Moon in "outer space", and now we will have aquanauts who will go down to the "inner space". The U.S. Navy is developing a deep-sea research station that is totally independent of surface ships once placed on the ocean bottom. The adjustable legs making it possible to compensate for small slopes and bumps in the sea bed. It is designed to provide accommodation for five aquanauts or scientists, working on research, for month-long periods at depths of up to 5,500 ft. Observation spheres are fixed to the bottom hull with laboratory and scientific instrument compartments on the lower levels and living quarters above. These are all placed within the steel pressure-proof hull.

KEY TO NUMBERED PARTS  
(1) Support discs on sea bed. (2) Adjustable legs. (3) Forward observation spheres and floodlights. (4) Scientist taking observations of marine life. (5) Side observation spheres. (6) Entrance chamber to spheres. (7) Free-flooding tanks around pressure-proof hull; these give stability when the vessel is on the sea bed. They are blown free of water when on the surface, to give buoyancy. (8) Scientific instrument room and research laboratory. (9) Living quarters. (10) Cable drums for hoisting vessel to surface. (11) Rear section of pressure hull. (12) Entrance hatch to forward section. (13) Main hatch. (14) Telephone cables to ship on the surface, if one should be in attendance.



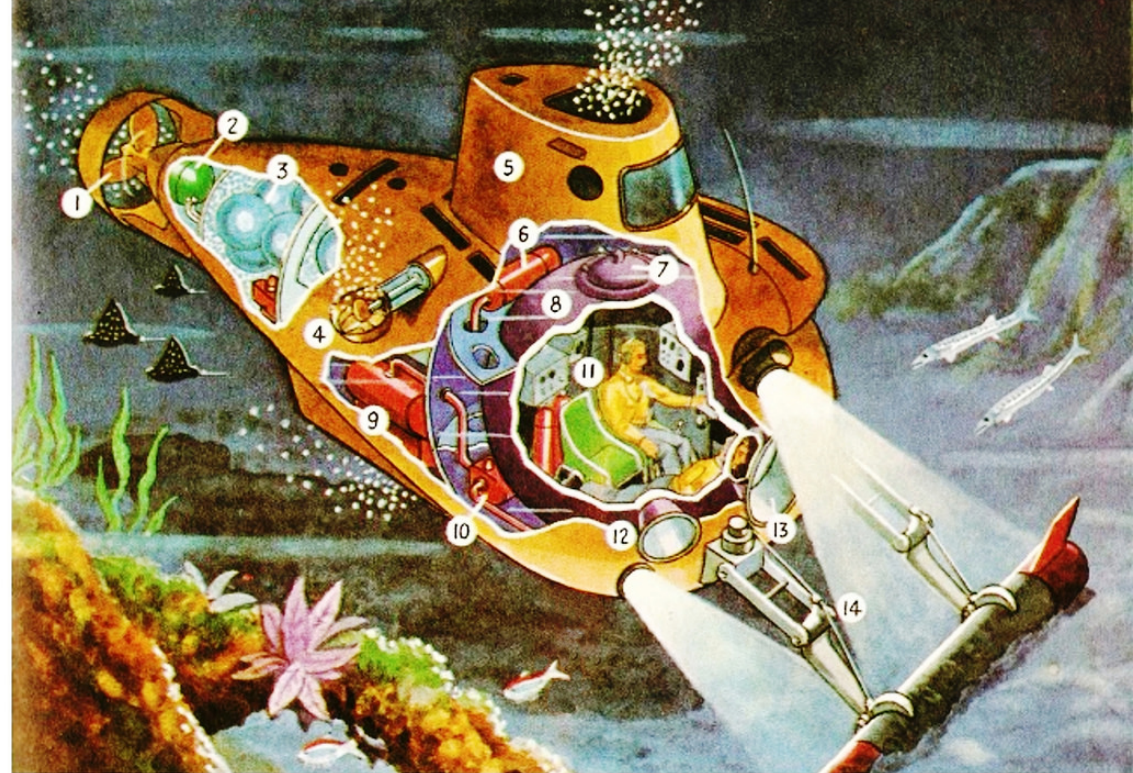
U.S. NAVY STATION



## GOING DOWN TO 6,000 FEET

AMERICA is perhaps the most forward nation in the world in Oceanography, with interests spreading all over (and under) the oceans. Apart from exploring the sea bed, some submarine-like vessels are used for deep-sea salvage. One such vessel is the Alvin, which can operate at 6,000 ft., where water pressure is 2,780 lb. per square inch. The aquanauts work inside a thick steel pressure-proof sphere, the surrounding superstructure is flooded with sea water so that pressure inside is the same as that outside. Mechanical arms and claws, operated from inside the hull, can pick up marine specimens from the sea bed or salvage other objects. Down and up movements of Alvin are controlled by oil-filled floatation bags.

KEY TO NUMBERED PARTS  
(1) Forward and reverse propeller can be moved sideways for steering. (2) Electric propulsion motor. (3) Air-filled buoyancy spheres. (4) Vertical control propellers — both sides. (5) Free-flooding superstructure. (6) Compressed-air reservoir for blowing ballast tank of sea water when rising to surface. (7) Entrance hatch. (8) Steel pressure-proof sphere. (9) Oil-filled floatation bag regulating descent and ascent of vessel. (10) Oil transfer pump. (11) Control panel with direction gyroscope, depth recorder, radio telephone, etc. (12) Side viewing port. (13) Main viewing window with cine camera, floodlight above. (14) Mechanical arms and claws.



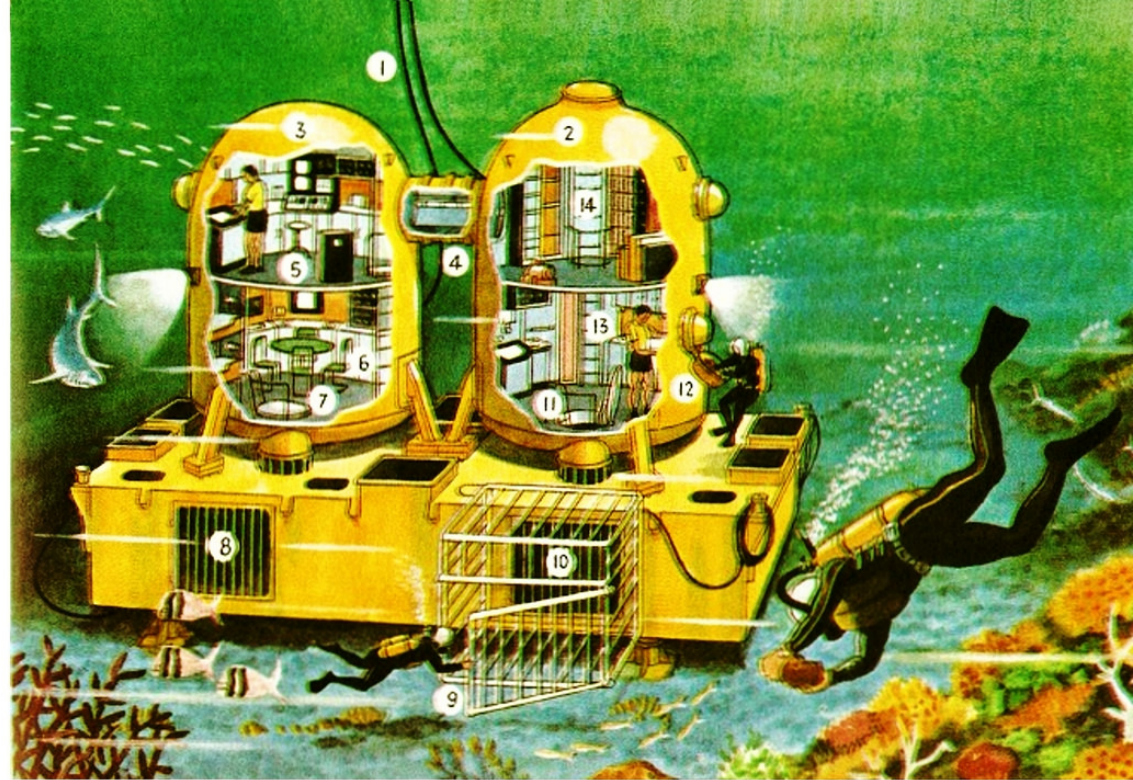
ALVIN - RESEARCH VESSEL



# LIVING ON THE OCEAN FLOOR

**T**EXTITE II is the name given to an American underwater laboratory in which five scientists are to live and work on the ocean floor for 60 days. Textites are small glassy mineral objects found in the ocean and believed to have come from "outer space". Textite II is in a depth of 50 ft. on the Continental Shelf near the Virgin Islands in the Caribbean Sea. The scientists work inside and outside two cylindrical steel tanks 18 ft. high, with two rooms in each. They will study marine geology, fish life and underwater maps. The tanks are connected by a tunnel 4 ft. in diameter. Closed-circuit television will be the scientists' only link with the outside world. The tests will prove whether men can easily endure living for long periods on the ocean floor.

**KEY TO NUMBERED PARTS**  
(1) Breathing mixture of oxygen and nitrogen supply lines from a surface ship. (2) Right-hand cylinder, 18 ft. high and 12 ft. in diameter. (3) Left-hand cylinder. (4) Connecting tunnel. (5) Control-room and laboratory. (6) Crew quarters with cooking galley, bunks, etc. (7) Entrance hatch from base structure. (8) Cage door (closed). The base contains 175,000 lb. of ballast and is anchored to the sea bed. (9) Outer cage protection against sharks. (10) Inner cage door. (11) Entrance hatch from base. (12) Diver placing specimens in collecting tray – to be taken inside through an air-lock. (13) "Wet" room for diver's equipment. (14) Power-room and switch-board.



TEXTITE II - STATION (Front Cover)



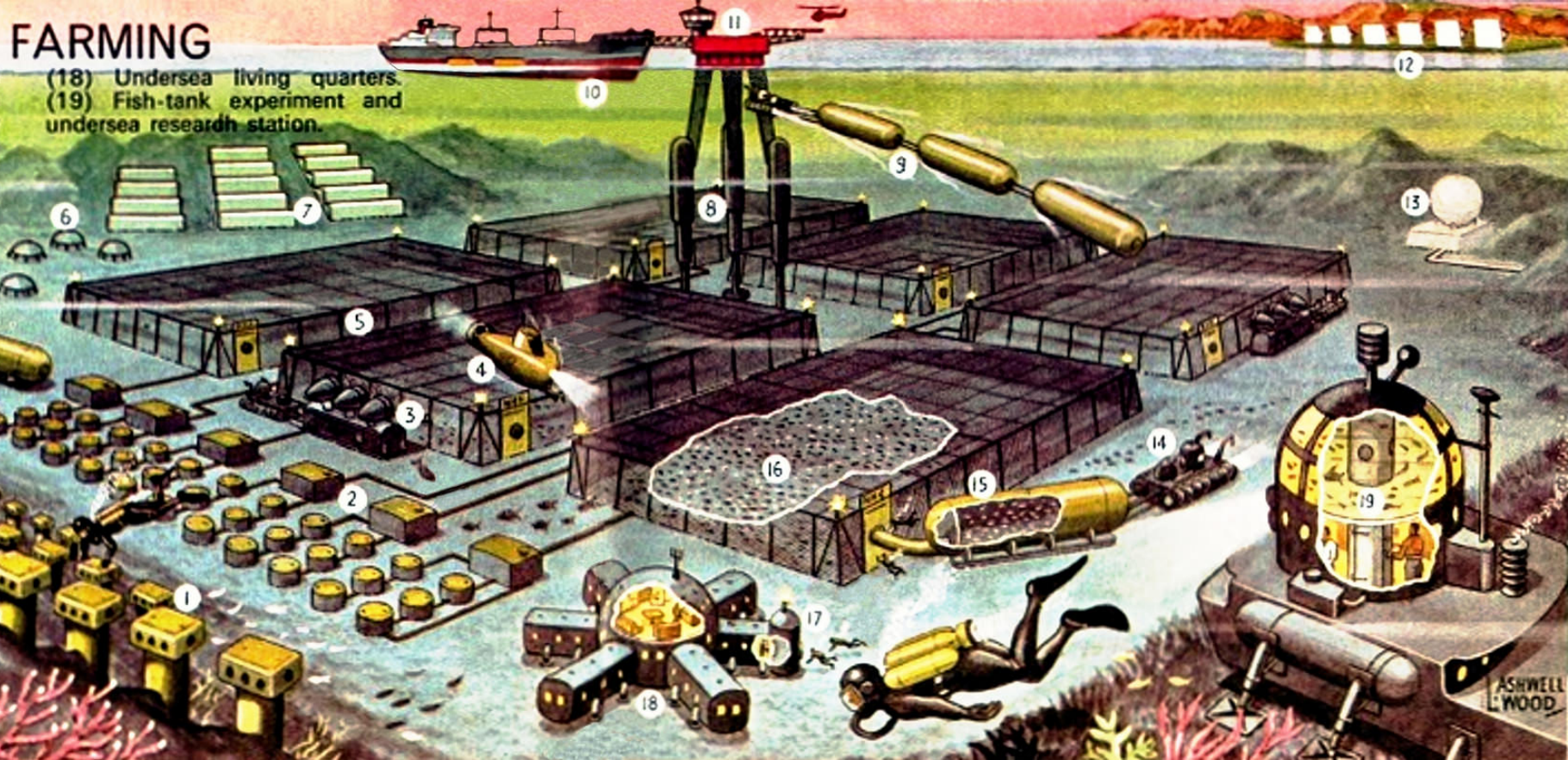
# UNDERSEA FISH FARMING

MAN is discovering the fertile sea bed as a great new source of food, and fish farming is likely to become a necessity as the problem of feeding the ever-growing population of the world increases. This is an impression of a fish farm of the near future.

## KEY TO NUMBERED PARTS

(1) Fish hives containing spawn.  
(2) Fish hatcheries. (3) Feeding machine sends food into cages.  
(4) Submarine supervising operations. (5) Nylon mesh fish cages.  
(6) Lobster breeding pots. (7) Crab and oyster breeding. (8) Gantry on sea bed. (9) Fish containers' transporter to surface ship.  
(10) Fish factory ship. (11) Moving gantry and helicopter platform.  
(12) Giant sun mirrors promote growth of marine fish food. (13) Atomic power station. (14) Jeep transporters. (15) Fully grown fish extracted into container.  
(16) Fertilised eggs are piped into the cages - here the fish breed. (17) Divers entering air-lock.

(18) Undersea living quarters.  
(19) Fish-tank experiment and undersea research station.

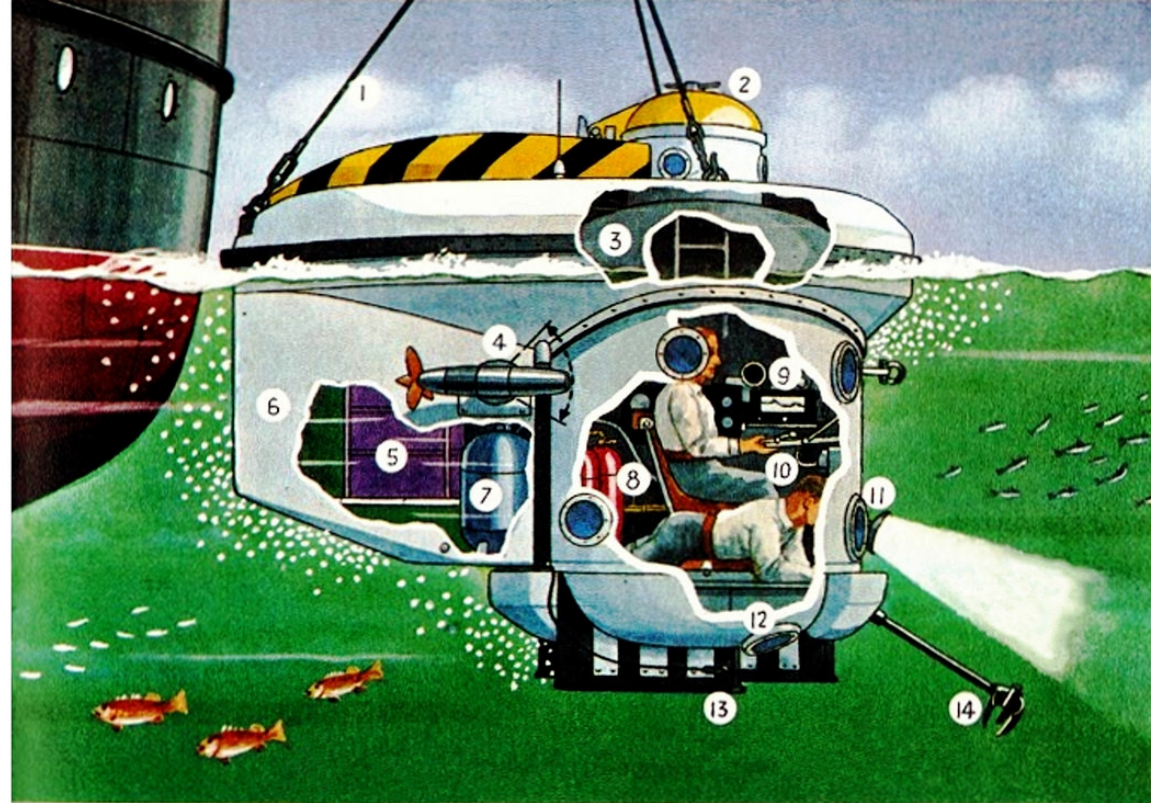




## SUBMERSIBLE RESEARCH VESSEL

BRITAIN'S first undersea craft known as SURV (Standard Under-sea Research Vessel) is a two-man vessel capable of working at depths up to 1,000 ft. on the Continental Shelf off the coasts of the British Isles. Geologists will study the sea beds for gravel and mineral deposits, make surveys for the laying of natural gas pipelines, oil pipelines and telephone cables. There are ten viewing ports in the large steel pressure-proof hull and a mechanical claw for picking up specimens. Two electric motors and propellers can be rotated through 100° to drive the craft in any direction at a speed of  $2\frac{1}{2}$  knots. These can be used for descending to the sea bed, forward and reverse travel and ascending. The superstructure around the pressure-proof hull is free-flooding.

**KEY TO NUMBERED PARTS**  
(1) Craft being launched from support ship. (2) Entrance hatch. (3) Steel pressure-proof hull to withstand sea pressure of over 600 lb. per square inch. (4) Electric propulsion motors (each side) – these can be rotated to give vertical or horizontal movement. (5) Batteries for electric power supply. (6) Free-flooding area. (7) Compressed-air cylinders for blowing sea water when ascending. (8) Oxygen bottles for crew breathing apparatus. (9) Depth recorder, directional gyroscope, etc. (10) Two control arms for all operations. (11) Forward viewing port and cine camera. (12) Downward viewing port. (13) Ballast weights and support legs. (14) Mechanical claw.



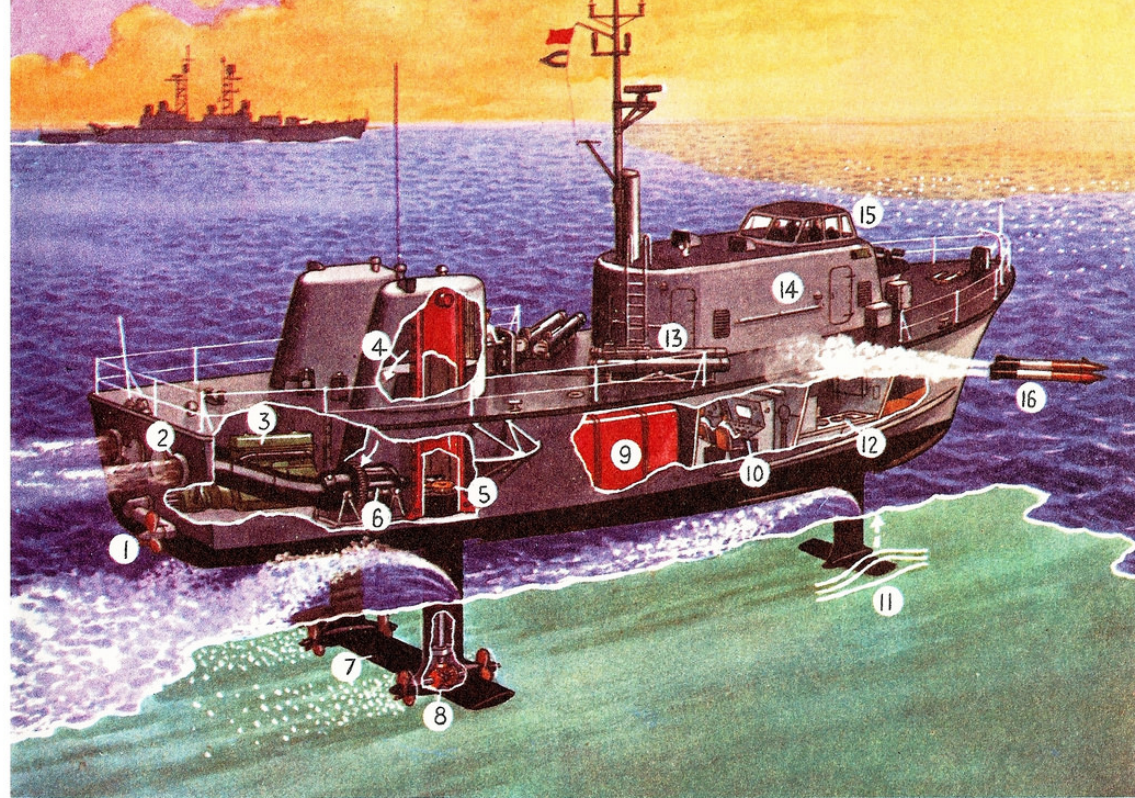
SURV - RESEARCH VESSEL



# HIGH SPEED HYDROFOIL

**T**HIS anti-submarine patrol boat is the high-speed hydrofoil vessel *High Point* of the United States Navy. It is provided with two lifting surfaces or foils, mounted beneath the hull. When at speed these foils give sufficient lift to raise the hull above water, thus reducing water resistance, so that less power is required to attain a given speed. In shallow water at low speed, the hydrofoils are retracted into the hull and an ordinary propeller used in the normal way. *High Point* is powered by two British gas turbine engines driving the hydrofoil propellers and a diesel engine for the outboard propeller. Speed, 54 knots (about 62 m.p.h.); length, 115 ft.; width, 31 ft.; weight, 110 tons. Twin anti-submarine missile tubes are port and starboard, firing forwards outside the bows.

**KEY TO NUMBERED PARTS**  
(1) Outboard propeller for low speed when craft is resting on water. It is raised clear for hydrofoil operation. (2) Gas turbine engine exhaust outlets. (3) 600-h.p. diesel engine for driving outboard propeller. (4) Engine air intakes and casing for hydrofoil struts when retracted. (5) Right-angle gear drive to hydrofoil propellers. (6) Rolls-Royce 'Marine Proteus' gas turbine engines – 3,100 h.p. each. (7) Rear hydrofoils. (8) Propellers turning in opposite directions. (9) Fuel tanks. (10) Operations room for guided missiles. (11) Path of water over forward hydrofoil, giving lift similar to an aircraft wing. (12) Galley – crew's quarters forward. (13) Starboard anti-submarine guided missile tubes. (14) Radio-room. (15) Control cabin. (16) Guided missiles fired on to target.



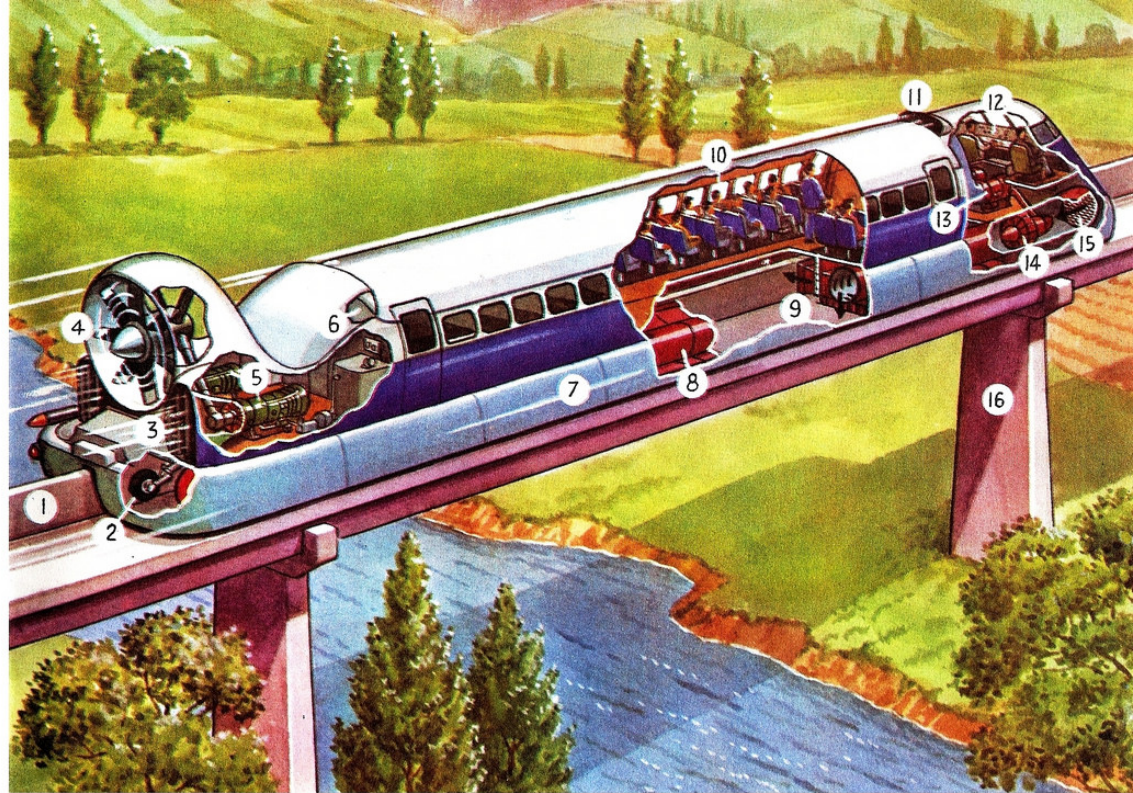
HYDROFOIL PATROL BOAT



# A TRAIN WITHOUT WHEELS

A 160-m.p.h. Hovertrain is the latest idea in air-cushion vehicles. An 80-seater vehicle is to run the 70 miles between Paris and Orleans, France. It is propelled from the rear by two 1,500-h.p. gas-turbine engines driving a reverse-bladed propeller. In front a 400-h.p. gas-turbine engine drives two axial-flow fans, one each side, which supply high-pressure air for the air cushion lift and the air cushion against both sides of the central guidance rail. The train glides on an elevated concrete track on a half-inch cushion of air. In places, the track is 16 ft. above the ground to clear existing roads and rivers. The 80-seater passenger cabin is air-conditioned and soundproof. The vehicle is 84 ft. long and weighs 20 tons loaded.

**KEY TO NUMBERED PARTS**  
(1) Central guidance rail. (2) Retractable wheels, each end, can be lowered when the vehicle is at rest at stations, etc. (3) Engine exhaust ducts. (4) Seven-bladed propulsion propeller. (5) Two 1,500-h.p. Turbo gas-turbine engines driving propeller. (6) Air inlet to engines. (7) Aluminium sheet side-walls. (8) Tubular air-cushion skirt runs whole length of train – both sides. (9) High-pressure cushion air provides lift from the track and a cushion both sides of central guidance rail. (10) Air-conditioned passenger cabin. (11) Engine exhaust duct. (12) Driver's cab. (13) Turbomeca 400-h.p. gas-turbine engine driving two fans. (14) Axial-flow air-cushion fans. (15) Air inlet to fans. (16) Elevated concrete track.



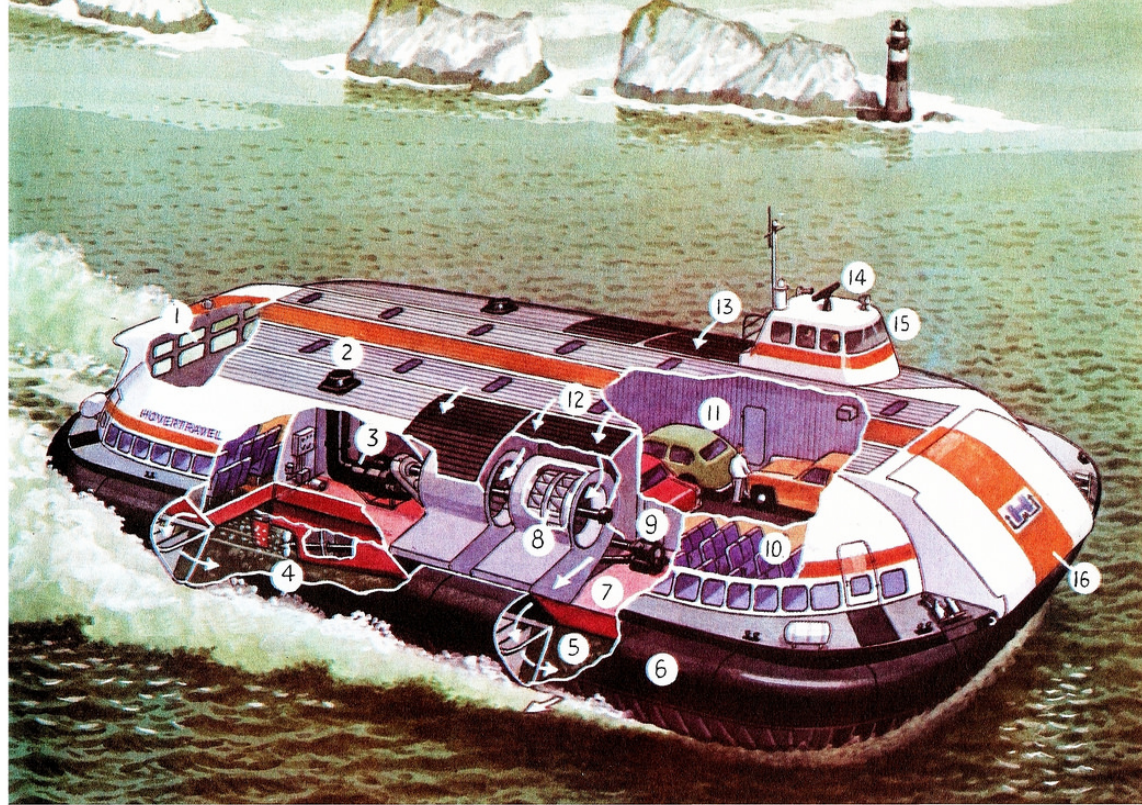
HOVERTRAIN



# A NEW IDEA IN HOVERCRAFT

**A**N entirely new conception in air-cushion vehicles is the huge 76-ton Vosper VT-1. Instead of the usual aircraft type propellers for propulsion, it has two underwater propellers similar to a ship. Two gas-turbine engines drive four airlift fans mounted end to end in two pairs. These supply the cushion air in the usual way. The two engines also drive two propellers underneath the craft for forward propulsion and reverse. The VT-1 is shown here, in the colours of Hovertravel, passing the Needles, Isle of Wight. It can carry 10 cars and 162 passengers, or converted to carry 324 passengers, at a speed of 40 knots. Length, 95 ft. 6 in.; width, 44 ft. 6 ins. Hovertravel propose to run the VT-1 between Bournemouth and the Isle of Wight.

**KEY TO NUMBERED PARTS**  
(1) Rear observation cabin. (2) Engine exhaust ducts. (3) One of the two 1,850-h.p. Avco Lycoming marine gas-turbine engines. (4) Right-hand propeller and rudder. (5) Cushion air flow. (6) Flexible skirt. (7) Buoyancy tank. (8) Twin mounted centrifugal fans for air lift – each side. (9) V-drive gearbox from engine to propeller shaft. (10) Forward passenger cabins – each side. (11) Car deck for 10 cars – can be converted to passenger seats. (12) Right-hand engine and fan air inlets. (13) Left-hand air inlets. (14) Searchlight and radar scanner. (15) Control cabin for commander, second officer, and radio operator. (16) Upwards opening door and front loading ramp – these are operated by hydraulic jacks.



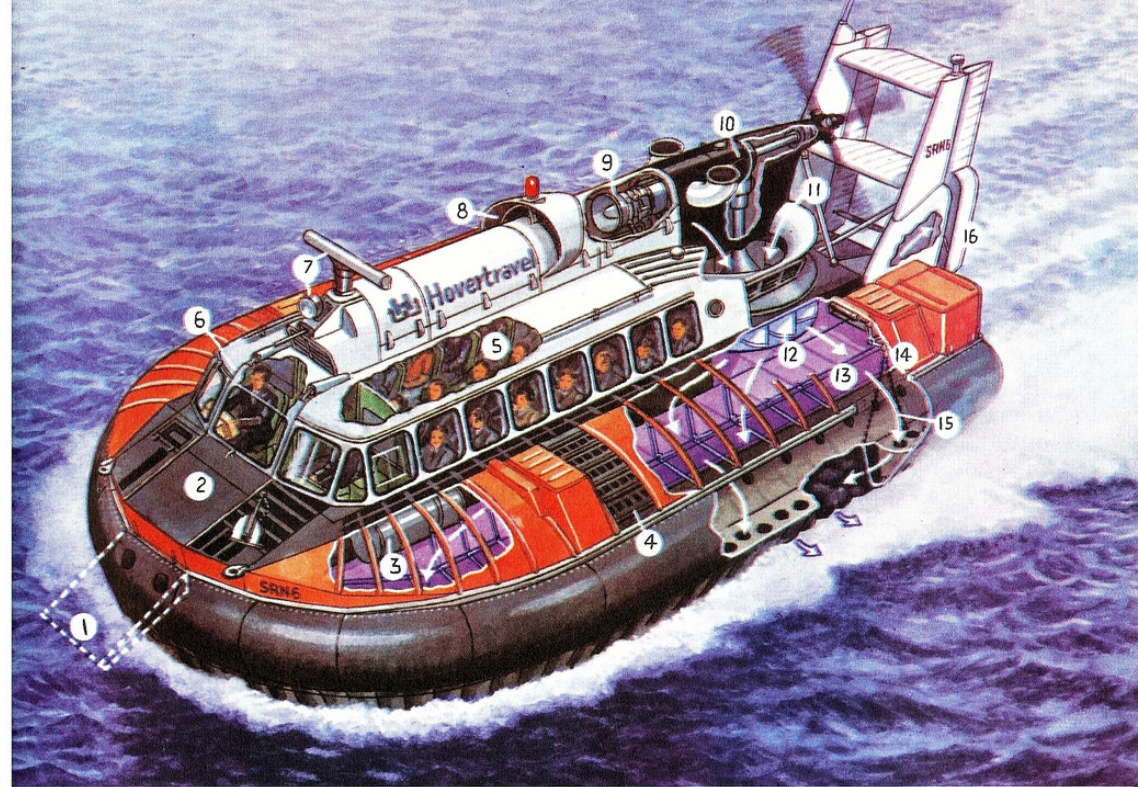
VOSPER VT-1



# SKIPPING ACROSS THE SOLENT

**P**ASSENGERS travelling to and from the Isle of Wight enjoy the most up-to-date means of transport. In a mere ten minutes, they can cross from Southsea to Ryde, Isle of Wight, in one of the most successful hovercraft ever built – the Winchester Class SR.N6. Designed as a fast passenger ferry service for coastal waters, the Winchester can carry 38 passengers in its cabin, which can be converted to carry an alternative load of 3 tons of freight. It is powered by a 900-h.p. Rolls-Royce "Marine Gnome" gas-turbine engine, which drives both the lift fan and the propulsion propeller. Top speed in calm water is 52 knots. The military version of the Winchester is in service with the British Army and the Royal Navy, also in many parts of the world.

**KEY TO NUMBERED PARTS**  
(1) Position of loading door when lowered. (2) Loading door. (3) Fuel tank. (4) Walkway. (5) Passenger cabin. (6) Driver and upwards opening door. (7) Searchlight and radar scanner. (8) Ram air intake for engine. (9) Rolls-Royce "Marine Gnome" gas-turbine engine. (10) Gearbox drive to lift fan and propeller. (11) Air inlet to fan, and also main air inlet to engine. (12) Centrifugal lift fan. (13) High-pressure air flow through plenum chamber and over buoyancy tank. (14) Skirt control chains for raising or lowering the flexible skirt to control the air cushion. (15) Flexible skirt and "fingers". (16) Air supply to assist steering of the aircraft-type rudders for directional control.



WINCHESTER CLASS SR.N6

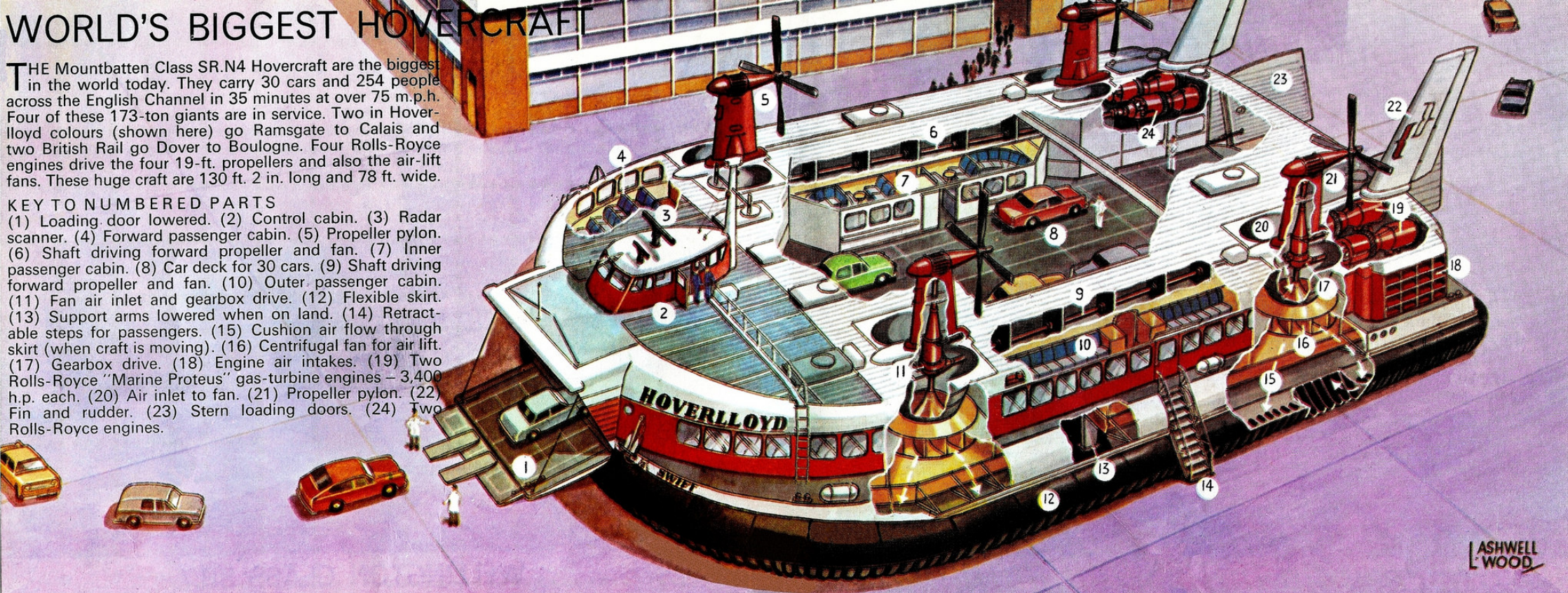


# WORLD'S BIGGEST HOVERCRAFT

THE Mountbatten Class SR.N4 Hovercraft are the biggest in the world today. They carry 30 cars and 254 people across the English Channel in 35 minutes at over 75 m.p.h. Four of these 173-ton giants are in service. Two in Hoverlloyd colours (shown here) go Ramsgate to Calais and two British Rail go Dover to Boulogne. Four Rolls-Royce engines drive the four 19-ft. propellers and also the air-lift fans. These huge craft are 130 ft. 2 in. long and 78 ft. wide.

## KEY TO NUMBERED PARTS

(1) Loading door lowered. (2) Control cabin. (3) Radar scanner. (4) Forward passenger cabin. (5) Propeller pylon. (6) Shaft driving forward propeller and fan. (7) Inner passenger cabin. (8) Car deck for 30 cars. (9) Shaft driving forward propeller and fan. (10) Outer passenger cabin. (11) Fan air inlet and gearbox drive. (12) Flexible skirt. (13) Support arms lowered when on land. (14) Retractable steps for passengers. (15) Cushion air flow through skirt (when craft is moving). (16) Centrifugal fan for air lift. (17) Gearbox drive. (18) Engine air intakes. (19) Two Rolls-Royce "Marine Proteus" gas-turbine engines - 3,400 h.p. each. (20) Air inlet to fan. (21) Propeller pylon. (22) Fin and rudder. (23) Stern loading doors. (24) Two Rolls-Royce engines.





# Shafts Of Power

Sunbeams can do more than light the world — one day, they may generate over half the world's electrical energy

JUST as the Druids of ancient Britain and the Aztecs of South America worshipped the sun for its warmth and comfort, so mankind today is looking to the star 150 million kilometres away in space to answer the world's energy problems in the next century.

The precious solar resources streaming from the sun — nature's own thermo-nuclear power house — are becoming increasingly important with oil supplies due to start dwindling rapidly after the arrival of the new millennium. Science has already made a start at harnessing solar energy as a practical future alternative to oil, which now fuels industries, keeps transport moving on land, sea and in the air, and heats homes, schools and factories.

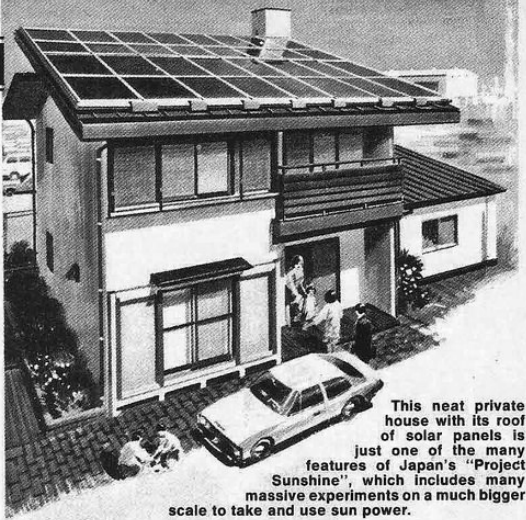
But time is running out, so more than 30 governments throughout the world are pumping more and more money into scientific research devoted to capturing the power of the sun as a cheap and easy form of energy. In acclaiming 1978 as The Year of the Sun, the United States has underlined the gravity of the world fuel situation and raised its contribution to solar research to £110 million compared with a mere £4 million only three years ago.

President Carter's own acknowledgement of the sun as the

energy source of the future came when he watched his inauguration parade from a specially built £85,000 review stand heated by solar energy. A chill wind swept through Washington's streets that day but the president removed his overcoat to watch the procession from within the warm confines of his platform. He has been advised that half of America's power demands could be provided by the sun by the year 2020: an apparently realistic goal since 15,000 times as much energy as the whole world consumes hits the earth from sunlight every day.

So the US forges ahead with its sun-catching programme. A new solar energy research institute is to be built in the appropriately named town of Golden in Colorado. Washington has also promised that £5 million worth of grants will be made available to private homes, motels and hotels to test solar water heaters — the most practical application of solar energy so far.

Plenty of other imaginative uses are being developed. Emergency call boxes on Washington's Beltway, a six-lane ring road, are already being powered by the sun. And scientists are busy studying other solar benefits for the future such as solar-powered crop drying, traffic lights that operate from sunlight and min-



This neat private house with its roof of solar panels is just one of the many features of Japan's "Project Sunshine", which includes many massive experiments on a much bigger scale to take and use sun power.

eral processing with solar-heated steam.

They believe, too, that space stations can be created to act as special channels for solar energy. In 1985 one of the most fantastic engineering projects of all time will get under way when an experimental solar energy satellite will be launched into space to beam down power straight into national grids.

Hundreds of solar reflectors, each about 30 square miles in size, will be placed in synchronous orbit 22,300 miles (36,000 km) above the Equator, enabling them to stay above the same spot on earth. They will direct solar energy to Earth in the form of microwaves. These rays will be relatively weak in intensity — aircraft passengers passing through them would not be harmed — but containing colossal electrical power. The gigantic space station under consideration would be designed to send 5,000 megawatts to earth — about one-tenth of the entire output of Britain's present national grid.

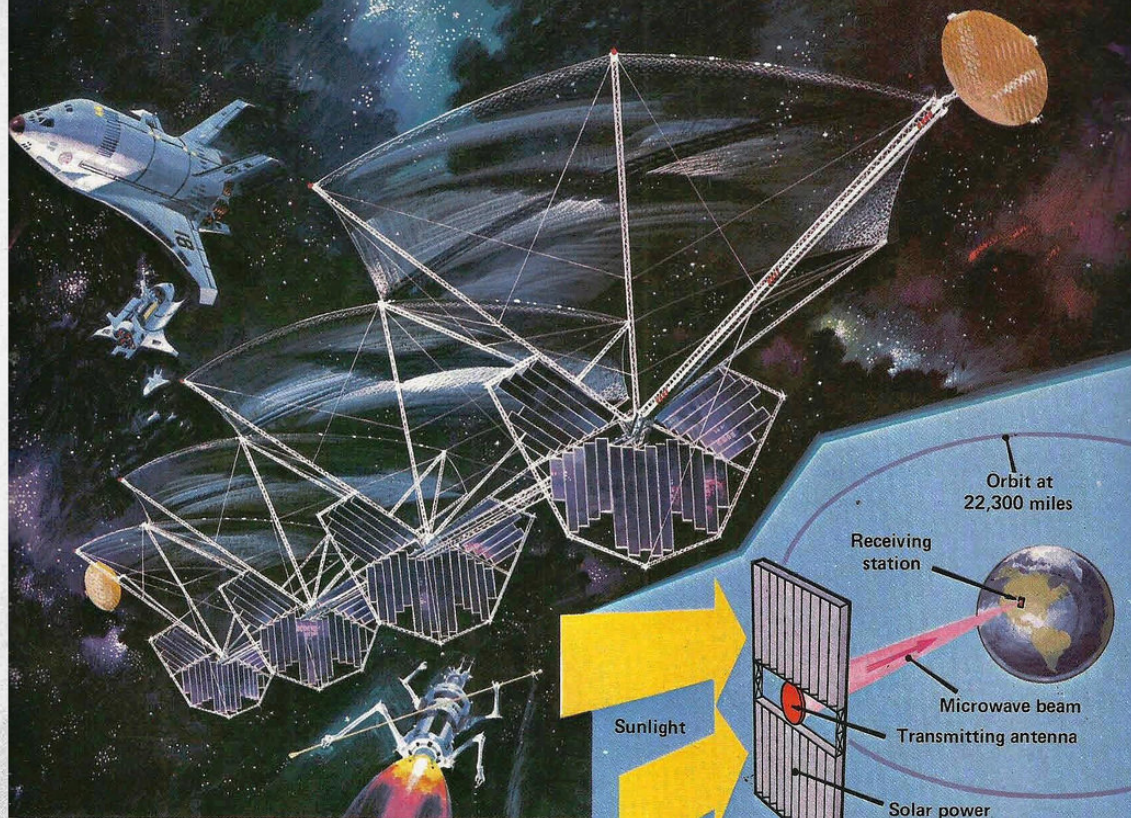
Yet another estimate of

future developments was provided at a recent international solar energy congress in New Delhi. There scientists reckoned that by 1985 solar energy would provide one to two per cent of the world's mechanical and heat energy. The figure could rise to five or seven per cent by the year 2000.

New Delhi was an appropriate venue for the conference, as India ranks only second to Australia in the research being carried out in the East on solar prospects. Indian scientists are working on a solar-powered pump for irrigation, a solar device for drying rice products has been invented and, paradoxically, a New Delhi research institute has made a solar ice-making machine.

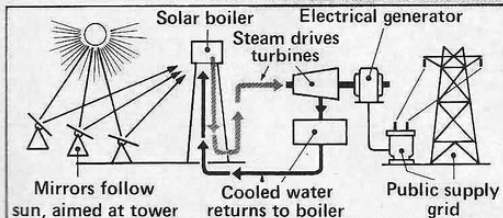
Yet it is a truism to say there is nothing new under the sun — even solar heaters. They were common in the USA from the later 1800s until the 1920s.

Today, after a 60 year gap, the sun is making a comeback. In the years ahead, science may well prove that it had the answer all the time.

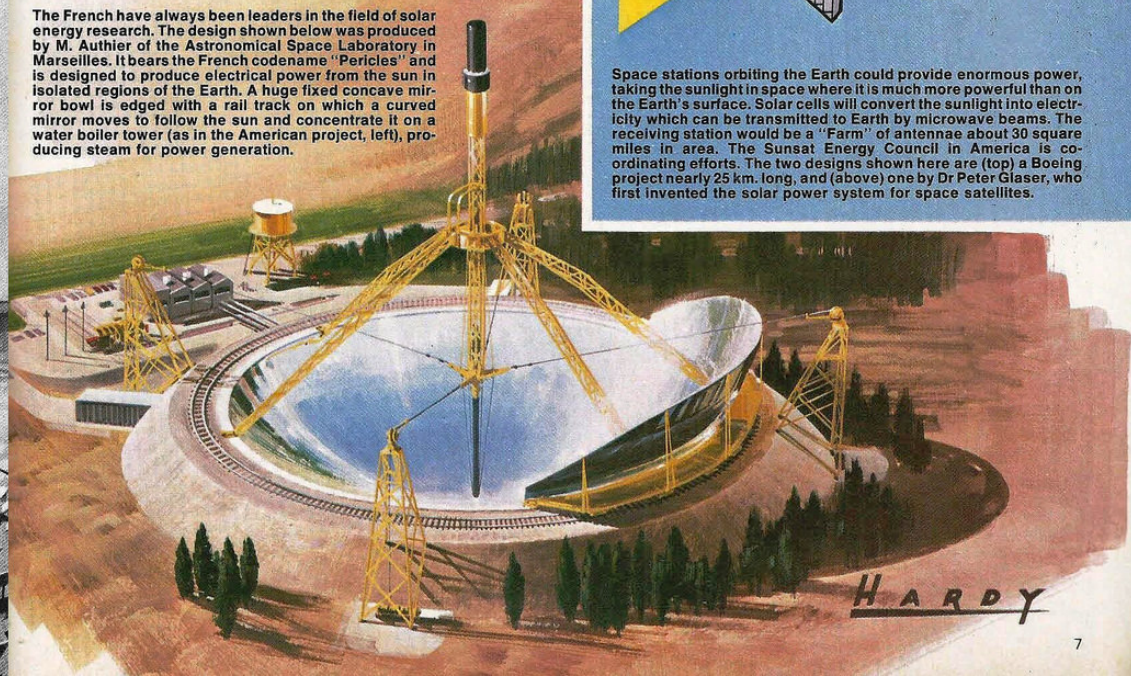
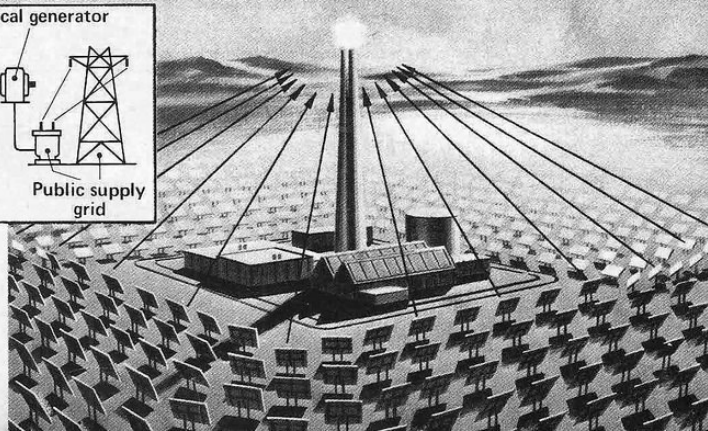


The French have always been leaders in the field of solar energy research. The design shown below was produced by M. Authier of the Astronomical Space Laboratory in Marseilles. It bears the French codename "Pericles" and is designed to produce electrical power from the sun in isolated regions of the Earth. A huge fixed concave mirror bowl is edged with a rail track on which a curved mirror moves to follow the sun and concentrate it on a water boiler tower (as in the American project, left), producing steam for power generation.

Space stations orbiting the Earth could provide enormous power, taking the sunlight in space where it is much more powerful than on the Earth's surface. Solar cells will convert the sunlight into electricity which can be transmitted to Earth by microwave beams. The receiving station would be a "Farm" of antennae about 30 square miles in area. The Sunsat Energy Council in America is co-ordinating efforts. The two designs shown here are (top) a Boeing project nearly 25 km. long, and (above) one by Dr Peter Glaser, who first invented the solar power system for space satellites.



When completed, this American project will be the world's largest solar furnace. Being built in the desert near Barstow, California, it comprises acres of reflecting mirrors to track the sun and concentrate its fierce energy on to a water boiler at the top of a 283 foot (86 m.) high tower. Steam produced will drive generating equipment to provide electrical power for a city of 10,000 people.



HARDY



# The Energy Explorers

Under the surface of our seas and beneath the Earth's crust lies enough energy to fuel the world for generations to come — if scientists find the resources and technology to tap it

**M**OST people in Britain learn very early that its mild winters are due to the waters of the Gulf Stream, which flows up from the Caribbean to warm our shores. What is not so generally known is that one single stretch of it could provide enough energy to keep the whole world supplied many times over.

The secret lies in the initials OTEC, which stands for ocean thermal energy conversion. It is one of the many energy schemes that governments and scientists are considering as alternatives to burning the limited supplies of fossil fuels such as coal, oil and gas. And as the 21st century approaches, and the energy crisis looms larger and larger, OTEC may well become a reality.

The idea is to use thermal differences between different levels of the ocean to generate power. The Gulf Stream, warm at and near the surface but cold underneath, is ideal for this purpose. Already, the American Lockheed company, famous for its aeroplanes, has worked out a detailed plan for a structure that could generate 160 megawatts, equal to about 15% of the output of a large nuclear power station.

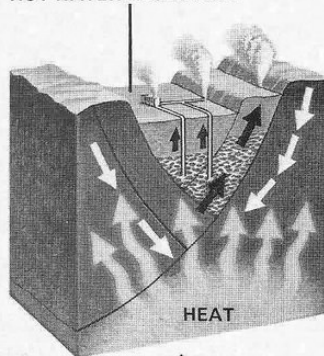
Under this plan, cold water would be sucked up from 450 metres below the surface by a giant concrete pipe. The temperature difference between this cold water and the warm water of the surface would be used alternately to condense a refrigerant, such as ammonia, into a liquid, then to turn it into a rapidly expanding gas to pass through a set of turbines, spinning them to generate electrical power.

One estimate of the power potential of a section of the Gulf Stream some 900

kilometres long by 25 kilometres wide, made by Professor Heronemus of the University of Massachusetts, is that it could produce some 2,000 million megawatts a year. Unbelievably, that is some 4,000 times the total amount of power currently generated annually in the USA.

Inland, it is not the cold, but the heat beneath the surface that is exciting the interest of the rising generation of energy explorers. A glance at the small country of Iceland will show why.

## HOT WATER RESERVOIR



↓ COLD WATER ↑ STEAM

Natural hot water and steam occur when water seeps underground and meets the Earth's heat coming up. It boils back to the surface and can be tapped by geothermal plants such as the one shown below. Such plants are always wreathed in clouds of steam.

This small island is situated just beneath the Arctic Circle, yet it has a flourishing market garden industry. The shops in the capital, Reykjavik, are full of home-grown tomatoes and cucumber, flower shops are full of local blooms, and even bananas have been grown. And all this in a country where the mean July temperature is a chilly 11°C (52°F).

The Icelanders manage this by tapping the hot water reservoirs which faults in the Earth's crust have created under their feet. These also supply many of the country's towns with enough hot water to bring central heating to all the houses.

Large underground hot water reservoirs exist in many parts of the world, though not all are so near the surface as in Iceland. Many are up to 50 kilometres deep. Yet scientists are convinced that the technology exists to drive a shaft down to them to utilise this hidden energy.

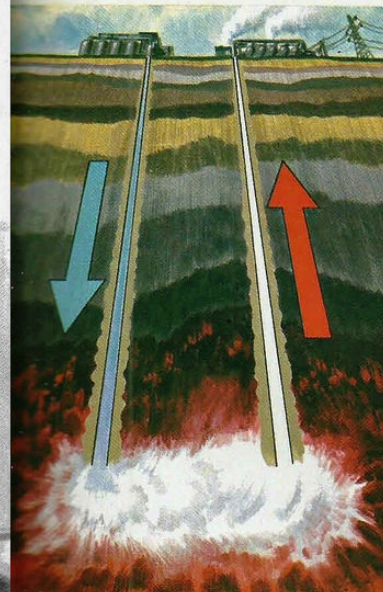
Another subterranean source that is being investigated is that of the so-called hot rocks. Much more common than hot-water reservoirs, these are hot belts of rock formed by the cooling of magma, the molten rock which makes up the Earth's core. They are frequently found only 10,000 feet below the surface, and scientists think they can force a way down to them. Then, cold water would be poured down, to be turned into superheated steam which would be tapped by a second well.

Science fiction, or future fact? The scientists working on these projects have no doubts: given the right resources, there is no limit to the energy they can place at the disposal of future generations.

Illustrated by Wilf Hardy



One way scientists have dreamed up of getting to the hot rocks which lie thousands of metres beneath the surface is to use white-hot metal drill heads. These would form shafts lined with the melted rock through which they pass.



Two shafts would have to be sunk to utilise the energy of the hot rocks. Down one, cold water would be poured. On contact with the rocks, it would flash into superheated steam and rush back up the second shaft. The steam would spin turbines in an electricity generating station directly above the shaft.

The OTEC — ocean thermal energy conversion — system is simple, but it would operate on a huge scale. It would use the difference in temperature between sea water at the surface and some 1,500 feet (450 metres) deep. The warm water would vaporise the refrigerant working liquid and force it through power-generating turbines. The cold water would condense it back into liquid form for recirculation. The Lockheed OTEC system shown here would use the force of the jets of water being expelled from the system to help keep itself in position.





## YOUR WORLD TOMORROW

# Where There's A Wind...

...there's an almost limitless source of energy which scientists are determined to harness for the benefit of future generations

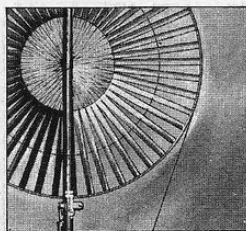
**T**O most people, windmills are relics from the pre-industrial past. They symbolise a bygone age when the slow sails of the village mill turned the stones that ground the grain into flour.

Windmills may have declined, but the wind has not. And scientists are now focusing their attention on wind as a possible solution to the world's energy problems.

Certainly, the British government believes there is a future in wind power. Under consideration at the moment is a plan to spend millions of pounds on a giant research windmill over 50 metres high and designed to produce between three and four megawatts.

The prospect is of a chain of windmills being set up in Britain's windier areas to seize the energy out of the air and convert it into electricity.

Proposals have also been made for floating windmills in the waters of the North Sea. These would send a constant stream of power flowing into the national grid.



Another new type of wind turbine is known as the "super speed turbine", or SST. Its unique feature is a belt running around its outer rim, connected directly to the generator to give maximum power.

Illustrated by Wilf Hardy

Research has shown that the potential power available from the wind is more than double the present output of all the world's power stations. So it is not surprising that many countries are devoting increasing sums of time and money to this exciting new area.

Projects under investigation at the moment vary from structures which resemble our traditional ideas of what a windmill should look like, to objects which look more like aeroplane engines. One plant, in New Mexico, USA, features a wind driven propeller turbine.

Not surprisingly, many of the American companies which are actively engaged in wind energy research are the ones with experience in the aerospace industry. Lockheed, for example, is convinced that by 1995 something like one-fifth of America's energy needs could come from wind power.

The soaring cost of imported oil is the main spur for America's interest in wind power. But to the north, in Canada, other considerations are motivating the Ottawa government to spend money on research.

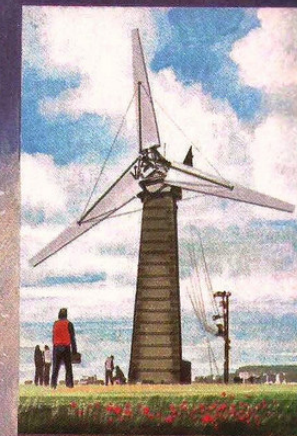
The Canadians have in mind the vast tracts of Arctic wasteland which cover the northern part of that country. Laying normal power lines to outlying townships in the Arctic circle is not just expensive — such power lines are also difficult and dangerous to maintain.

So the plan is to build a system of windmills to give light and power beyond the Arctic circle. A major advantage is that they could be installed where the power is needed. Russia, too, is pushing ahead with a network of wind power generating stations in the Arctic with a completion date set in the late 1980s.

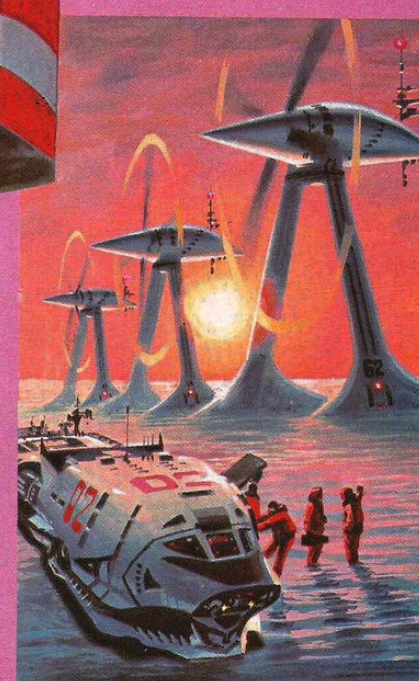
Many technical problems still need to be overcome, and research is centering on rotor blade and hub design. But scientists are confident that these can soon be overcome. And a skyline dotted with windmills may well be the prospect for the 21st century.

America's biggest vertical axis windmill, at Sandia Laboratories, Albuquerque, New Mexico, is part of an experiment to improve the efficiency of wind turbines. Now three-bladed, it produced 60 kilowatts of power in a 28 mph (45 km/h) wind in its two-bladed form.

This 200 kilowatt wind turbine is installed in the town of Clayton, New Mexico. It should eventually produce some 15 per cent of the town's power needs.

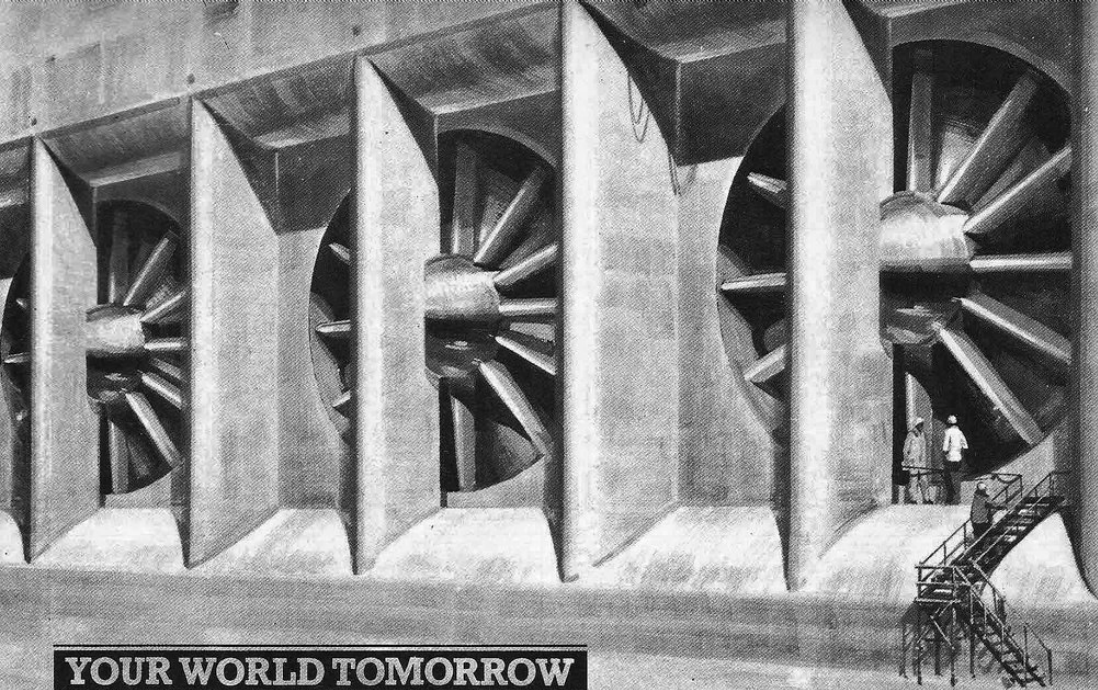


Above: this 30 kilowatt wind turbine at Aldborough, North Yorkshire, has been connected to the local electricity grid for over a year. Left: our artist's impression of what wind towers anchored in the North Sea might look like. They are using vertical axis turbines of the type shown on the facing page; one has been stopped for routine maintenance work. Generators would be contained in the upper of the two underwater spheres; the lower ones would contain water ballast.



Wind towers in the Arctic, sited close by the communities they would serve, could do away with the need for costly and vulnerable power lines from far-away power stations.





## YOUR WORLD TOMORROW

# When The Tide Comes In...

... scientists start dreaming of huge power stations on and beneath the waves as a means of solving the world's fast-growing energy problem

**T**HE immense power within the waves and the tides will become an integral part of the energy jigsaw of nations by the year 2000. This is the prediction of many scientists and technicians who are studying alternative methods of providing fuel as oil reserves sink lower and lower.

In laboratories and on drawing boards, a new picture of power by the end of this century is taking shape.

One of the most exciting projects designed to tame tidal power is already under way on the Atlantic coast of Canada. The government of Nova Scotia has ordered a multi-million pound investigation to find out whether the world's biggest tidal wave, which surges with a 15-metre rise and fall through the Bay of Fundy between the province and New Brunswick, can be harnessed to produce power for the future.

The idea of using these twice-daily waves for energy has been discussed for decades. Now that encouraging reports have been made on test drillings to find suitable sites for dams, a full-scale operation will be going ahead into the economic

possibilities of establishing a unique power complex within and alongside this waterway.

According to experts, once the construction plans have been approved a series of dams will be built, containing hundreds of holes — giving the underwater structure the appearance of a gigantic Swiss cheese. Into these holes, 30,000 generators will be placed. On the powerful ebb tide, fan blades like those in a jet engine will spin, creating magnetic fields on the rims of the generators to produce up to 9,000 megawatts.

Establishing the dam with its attendant power stations will call for an expenditure of billions of pounds. But tidal power, which is the only kind of energy that comes mainly from the Moon rather than from the Sun, has many attractive aspects. It is essentially self-renewing and, more important, non-polluting.

There are, in fact, about 30 suitable sites for tidal power stations in the world embracing an estimated energy potential of as much as 64,000 megawatts. For more than 10 years, the French have operated a 240-megawatt

plant on the River Rance near St Malo on the north-west coast of France. The results, however, have not been sufficiently encouraging for the Paris government to go ahead with plans for a larger tidal plant off the island of Mont St. Michel, where the tides race into the coast with the speed of racehorses.

### Bristol Project

In Britain, detailed studies into wave and tidal power have been made in recent years. Plans are being considered for a £4,000 million dam across the Bristol Channel linking Somerset with Wales — an idea that has been debated spasmodically since 1910.

The idea is to build an enormous barrage rising 30 feet above the water, with 300 turbine generators installed in 220 float caissons. As the fierce Severn tide rushes through, they will generate up to 8,000 megawatts — as much as the output of 12 of Britain's latest nuclear reactors.

Government approval has also been given for research into the power generated by the

waves themselves. Several systems have been developed to put rafts out at sea where the constant movement of the water could be used to operate hydraulic equipment to drive a generator.

Special attention has been focussed on the series of rafts designed by Sir Christopher Cockerell, inventor of the hovercraft. His raft consists of linked pontoons whose relative motion as they move up and down on the waves can be used to obtain energy, either by a gearing system or through hydraulic rams, which in turn operate electric alternators.

In a fully-fledged system a single raft — about 100 metres long and 50 metres wide — might generate two megawatts. So a series of rafts stretching over 25 kilometres and established some eight miles off the coast could provide the equivalent of a 500 megawatt power station.

But it is not a new idea: between 1856 and 1973 more than 340 wave energy systems were patented in Britain!

**NEXT WEEK:**  
Turning The Sandy Tide



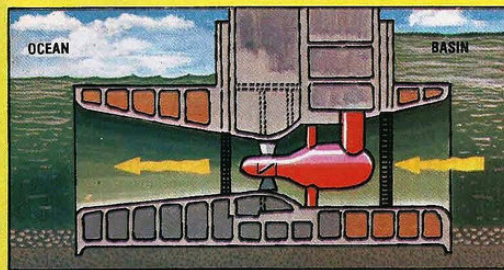
Illustration by Will Hardy

Hydraulic pumps compress and extend as rafts move to drive generators.

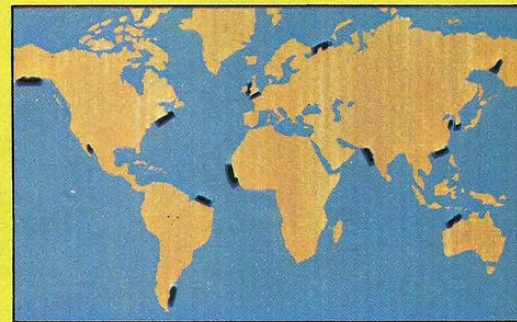


Hinged rafts follow movement of the waves.

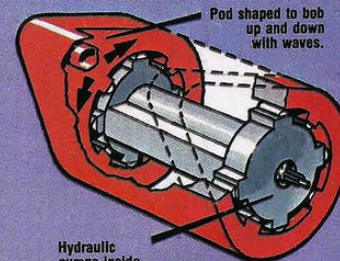
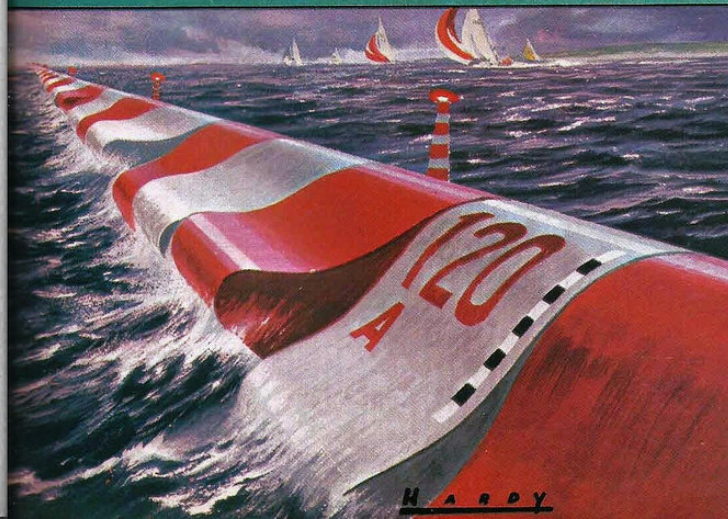
Left: our artist's impression of the wave energy devices known as contouring rafts. The brainchild of Sir Christopher Cockerell, inventor of the hovercraft, they would consist of a series of rafts in a line at right angles to the waves. The rafts would be hinged together, and the waves would lift them up and down. A special device would convert the between-raft movement into electrical energy. So far, only small models of this system have been made but, with a government grant, work is going ahead on a full-sized raft.



Above: a simplified cutaway of one of the turbine installations for the Bay of Fundy project. The turbines would be one-way, generating electricity only when the tide goes out. When the tide comes in, sluice gates are opened, then closed to form a dam to keep the water in a basin until the ocean level has sunk. Facing page: the mighty turbines will first be built in dry dock, then floated out and sunk in position in rows of four.



The map shows (in black) those areas of the oceans where the rise and fall of the tide is sufficient to allow the successful use of tidal barrier power generation.

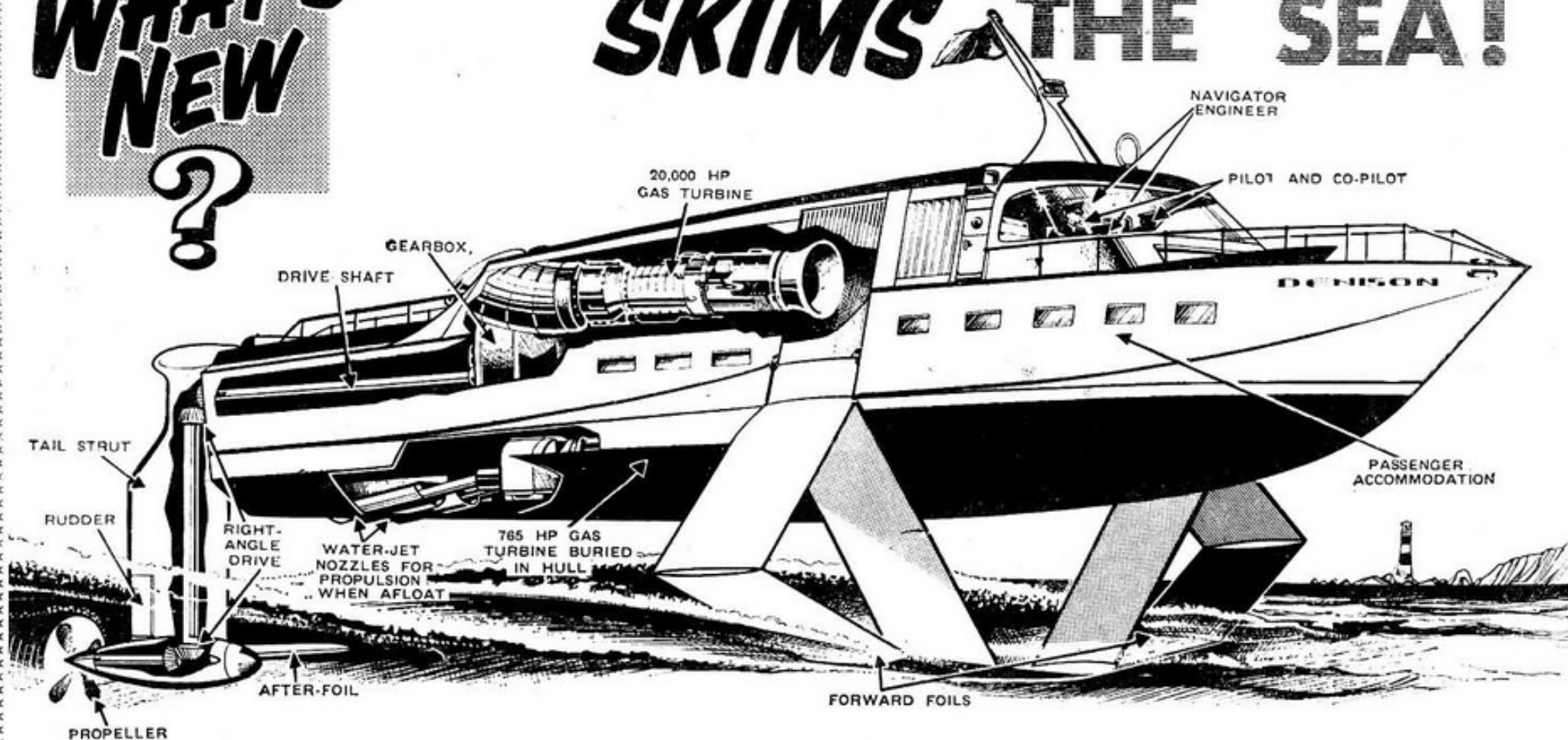


Left: probably one of the best-known devices for generating electricity from the waves is the system known as "Salter's ducks", after their inventor, Dr Stephen Salter of Edinburgh University. A specially-shaped pod rotates as waves pass over it, and a string of pods, placed parallel to the waves, would form a power station. Something like 90 per cent of the power in the waves can be retrieved, though converting it into useful electricity still causes problems.



# WHAT'S NEW ?

# THE SHIP THAT SKIMS THE SEA!



**D**ESPITE the ever-increasing development of the hovercraft, many countries are still continuing to produce hydrofoils—craft which can skim across the surface of the water, lifted by their wing-like foils, at speeds of up to 90 mph!

One of the very first successful hydrofoils was that built by Alexander Graham Bell as long ago as 1919. Even in those days, this new and revolutionary vessel touched the 70 mph mark, setting a world record for all waterborne vessels of its time.

Many and varied have been the experiments since those early pioneering days. One test even involved fitting foils to one of the famous wartime Ducks (DUKWs) amphibious vehicles which played such an important part in the Normandy and many other Allied landings. The ungainly Duck, its wheels just brushing the surface of the water, reached 35 mph on its submerged foils. The country which is at the present time making the most use of hydrofoil craft is undoubtedly Russia. With its hundreds of lakes and inland waterway systems, the Soviet Union has proved the ideal testing-

ground for the hydrofoil, and craft ranging up to the 50-ton size have carried hundreds of thousands of passengers.

Illustrated here is one of the newest American hydrofoils. Powered by a General Electric 20,000 hp gas turbine, the Denison will be able to carry eighty passengers in airliner-type seats within the soundproofed hull. Capable of some 70 mph cruising coupled with a range of over 850 miles the Denison may well enter service on the New York-Bermuda route, speeding holiday-making Americans down to the Bermudan sunshine.

The Denison's speed is achieved firstly by the large forward foils which can be retracted for docking, and by the simple over-stern right-angle drive, transferring the mighty engine's 25,000-lb thrust to the 36-inch propeller.

In addition to the Denison, the U.S. Navy is also constructing a hydrofoil sub-chaser, the first fighting ship to be built with foils.

LOOK OUT FOR ANOTHER SUPER CUTAWAY DRAWING NEXT WEEK!



# THE SEA-GOING SEA-LOADER

**I**f you laid three football pitches end to end you would have some idea of the size of the giant cargo ship in this picture.

But it is no ordinary cargo ship. In the first place, it breaks all the rules by being loaded at sea instead of joining the queue of ships waiting for space at some overcrowded and busy dockside.

Secondly, its cargo comes aboard already packed in containers — in reality huge barges — which are floated out to it and then hoisted aboard two at a time by a huge lift.

"Containerisation" is the name for this form of cargo transportation. In Britain and Europe it usually means loading containers in factory sidings and taking them by rail or road to the docks, for loading on to ships and transport to their destination.

But the Americans have their eyes on places where the waters are too shallow for the big ships to come close to the docksides. Their answer is the enormous ship in our picture.

Containers from a factory, or barges loaded in shallow water, are taken by tugs to the ships moored in an estuary or elsewhere in deep water. The containers are floated on to a lift which is beneath the level of the water. This raises them two at a time to the level of one of the three decks on which they are to be stowed.

Once on the deck, the barges are pushed into position by transporters, which are like moving platforms.

## THE CARGO KING

Now for some figures. In all, some 24,500 tons of cargo in 38 barges 97 ft. long can be loaded aboard the ship in just 13 hours, far away from docks and piers.

It would take more than a week to get this quantity of cargo aboard a conventional freighter at a dock.

In America, the first of these special cargo ships was launched on 10th July, 1971, and it really is amazing for it is the largest dry-cargo (as distinct from an oil tanker) ship afloat. Powering it is a 36,000 h.p. power plant to give it a speed of 20 knots.

If necessary, instead of barges, it has room for 1,800 twenty-foot containers, or vehicles that can be rolled on and off over almost three and a half miles of single lane "roadway," covering an enormous 146,000 square foot of deck space.

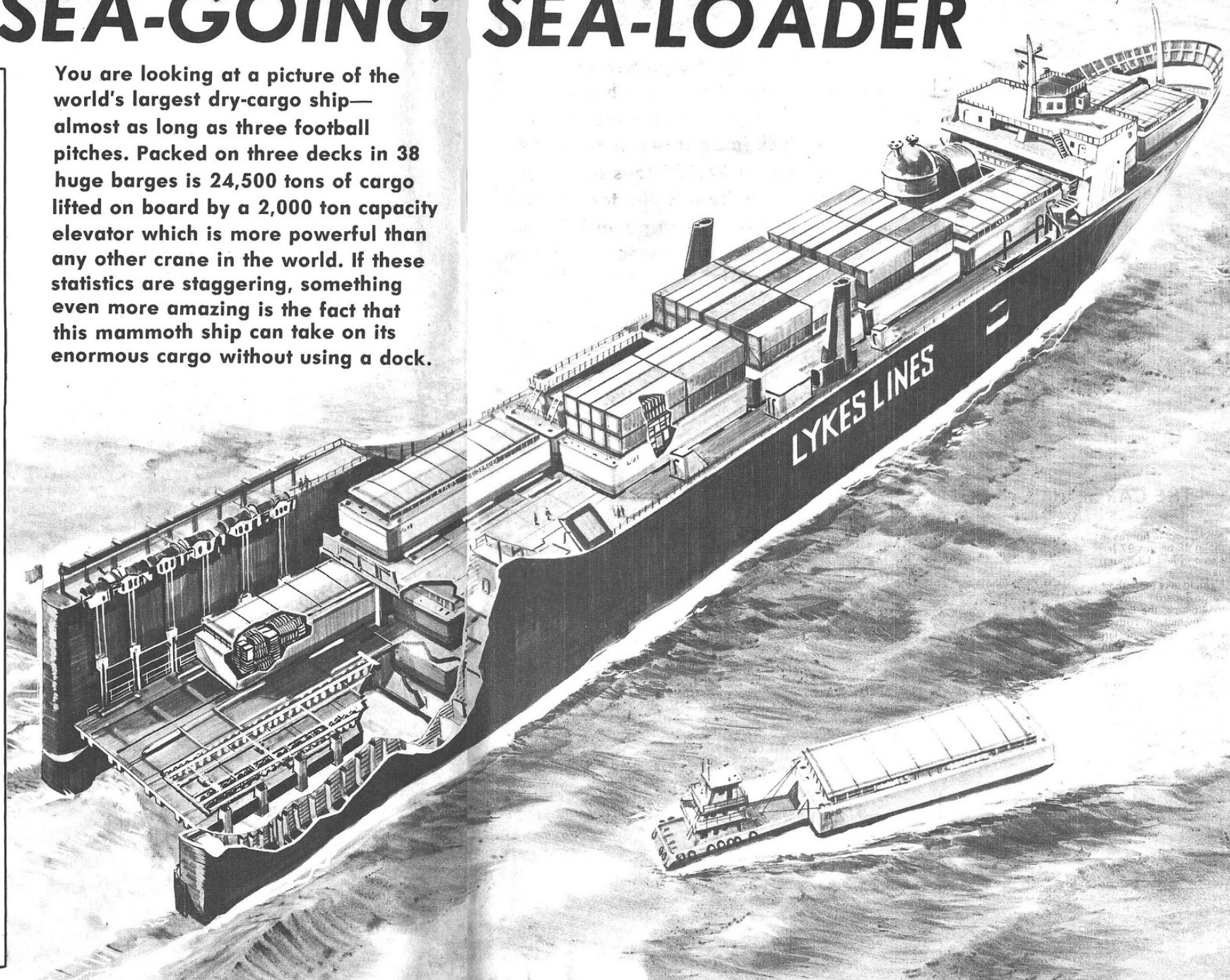
There is no reason for the cargo to be limited to containers. An assembled oil rig could be stowed on the upper deck space free of overhead restrictions. A helicopter, including a huge one called the Skycrane, can be flown from the upper decks, giving the freighter great value for military operations.

Called the "Seabee" system, this method was invented by the Lykes Brothers Steamship Company whose idea was to improve their freight service to places without deep-water ports.

In doing so, they linked the shallow harbours and inland waterways with the world-wide sea transport system and speeded up the distribution of goods throughout the world by sea.

This is important because while the air leads for passenger travel, for freight the sea is king.

You are looking at a picture of the world's largest dry-cargo ship—almost as long as three football pitches. Packed on three decks in 38 huge barges is 24,500 tons of cargo lifted on board by a 2,000 ton capacity elevator which is more powerful than any other crane in the world. If these statistics are staggering, something even more amazing is the fact that this mammoth ship can take on its enormous cargo without using a dock.





**Speed**  
6-Power

# THE PIGGY-BACK BARGE CARRIERS

Barges that can sail on canals and rivers and cross the seas on the backs or in the holds of mammoth ships are being used to speed up the flow of goods between the trading nations of the world.

On their way to inland terminals are these barges being pushed along the Mississippi River in the U.S.A. by a powerful tug.

Stern elevator of the *Atlantic Forest* which lifts barges to their storage decks. The tug shown is capable of pushing six barges to the parent ship. *Atlantic Forest* is designed to carry 73 barges stacked in two layers on its deck and in its hold.

**B**USY Middle Eastern ports, crowded with ships waiting for berth space, have created a problem for cargo-carrying vessels in recent years.

In common with other ports, unable to cope with the increasing interchange of goods between countries, they have shown that drastic re-thinking was called for by the ship designers.

The result of their work at the drawing board is both startling and obvious — startling because it represents a novel answer to the problem, and obvious because the best solution is often so close at hand it is frequently ignored.

What the designers produced was a vessel of great size able to carry a large number of barges. Such barges can be loaded at a dock in shallow water in about a quarter of an hour, and then towed by a tug to a waiting ship. After floating into the ship's stern well, they are then carried by a lift to the platform on which they are to be stowed.

The first of these barge carrying ships began service on the world's sea routes in 1969. So successful was this initial venture that there are now nearly 30 barge carriers plying their trade in every ocean.

LASH (lighter aboard ship) was the name applied to this concept. Launched in 1969, the first vessel of this type was built by Japan for a Norwegian firm. Named *Acadia Forest*, it was later joined by a sister ship, *Atlan-*

*tlic Forest* and was used to carry pulp and paper to Britain and western Europe.

Working with these vessels were 363 LASH barges. Each vessel carried 73 barges in its hold and stacked in two layers on its deck, these being carried to their position by a massive travelling crane.

CONTINUED ON NEXT PAGE

A method of loading barges on to a ship by the use of a submersible elevator at the stern is used in sea barge carriers known as Sea Bees. After the barge has been raised to its storage deck, it is carried to its stacking position by a transporter.

America then came on to the scene with an order for eleven vessels and several hundred barges. Each ship can carry 74 barges (or lighters) as well as 288 cargo containers of the kind you see carried by juggernaut lorries. A large crane was installed for loading the containers.

When they are fully loaded, these ships are carrying an enormously heavy cargo. Should the cargo slide about, it could topple the ship or give it a dangerous list.

To avoid this, the lighters and containers are firmly held in place, and the ships are fitted with stabilisers to avoid rolling.

Several American companies are now using LASH ships for carrying cargoes to and from the U.S.A., Middle East, Japan, South East Asia and Britain.

Europe came into the picture with an order for two LASH vessels each able to carry 83 barges. In the holds, 49 are stacked in four layers and on the deck 34 can be carried in two tiers. These single screw, diesel engine ships have a speed of 18 knots (about 20 mph or 32 km/hr).

All the barges carried by LASH vessels are of a standard size, the dimensions having been chosen to enable them to be used on European waterways, including those of Britain.

A method of loading barges on to a ship, by floating them on and off at the stern (mentioned at the start of this article) is incorporated in a series of ships known as Sea Bees (sea barge carriers). These have a lift at the stern which is below the water when a barge is floated over it. The lift then rises to carry the barge to any one of three decks. It is then stowed by a transporter.

Under the barge decks are vast tanks for carrying oil, so the Sea Bee could, in wartime, carry military vehicles as well as fuel for them. The routes link America and Europe, and Ireland received its first visit from a Sea Bee when one arrived in Dublin Bay and deposited barges there.

A similar idea was worked out for linking Britain's waterways with those of the Continent. A vessel named BACAT (barge aboard catamaran) was devised by a Danish ship owner. It was to run between Hull and Rotterdam.

Along one of Britain's inland waterways go two BACAT (barge aboard catamaran) barges. Pushing them is a British Waterways Board tug (left). Below is a BACAT ship on which barges are stowed. These were designed to provide a service between Hull and Rotterdam.

This diagram shows the twin hulls of BACAT 1, which was able to carry ten barges on its weather deck and three stowed between the hulls, as shown in this diagram. An elevator platform lifted barges to the weather deck, where they were placed on trolleys and moved by winches to their storage positions.

From these ports, the barges were to be pushed by tugs to inland destinations on canals and navigable rivers.

Our illustrations show the form these vessels were to take. The first was BACAT 1 which was used for a few years and then came out of service after opposition from dockers.

But generally, such vessels have been welcomed as a means of speeding up trade throughout the world and of keeping the life blood of commerce flowing.



# THE BUSY 'SEABEES'

**D**ESPITE the tremendous advances made in the size and efficiency of aircraft during the last half century, and their ability to carry both people and cargo rapidly over long distances, it is still one of man's earliest forms of transport—the ship—that remains the most economical means of bulk transport.

Moving things by sea does, of course, take much longer, because, although modern ships can travel faster than the early merchantmen, and have reduced the time taken for some journeys from weeks to days, a great deal of time is still involved in loading and unloading material at docks and harbours.

The ideal situation for a shipping company is to have a vessel capable of handling massive loads of around 2,000 tons unaided, and able to operate independently of any port facilities, so that it does not need to become involved in the time-consuming process of loading and unloading by the usual methods of cranes and barges.

Today, such vessels do exist, and a

**Cargo carriers with a difference are the Seabees whose storage holds are as compact as a beehive with their orderly stowage of freight-carrying barges**

number of them ply regularly between ports in the Gulf of Mexico and western Europe. They are called Seabees, and are the result of a brainwave by a man named Frank A. Nemeo of the American shipping company, Lykes Lines, which has its headquarters in the port of New Orleans, Louisiana, U.S.A.

Frank Nemeo realised that most of the cargo for their ships reached them by means of barges which had been towed down the mighty Mississippi and Missouri rivers. On arrival, the contents of the barges had to be labori-

ously transferred to the holds of his ships. Then, after the sea voyage the whole process had to be reversed.

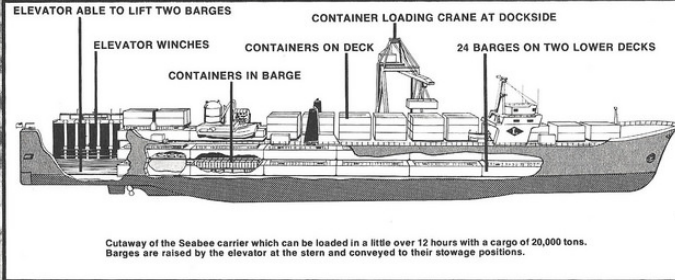
Why not, thought Frank Nemeo, have a ship into which whole barges could be loaded and unloaded, thus saving days of expensive waiting around ports? The Seabee ships are the outcome of this bold and imaginative idea.

You may remember reading about them in our 2nd July issue. An article entitled 'The Piggy-Back Barge Carriers' described various types of ships which sailed with barges stowed on their decks and in their holds. One of them, the Seabee, was mentioned briefly then. We thought readers would like to know more about it.

Each Seabee can accommodate 38 specially designed box-shaped steel barges with a carrying capacity of 850 tons. The barges are not just 'containers' but are so constructed that they can be towed through the water like any other river barge.

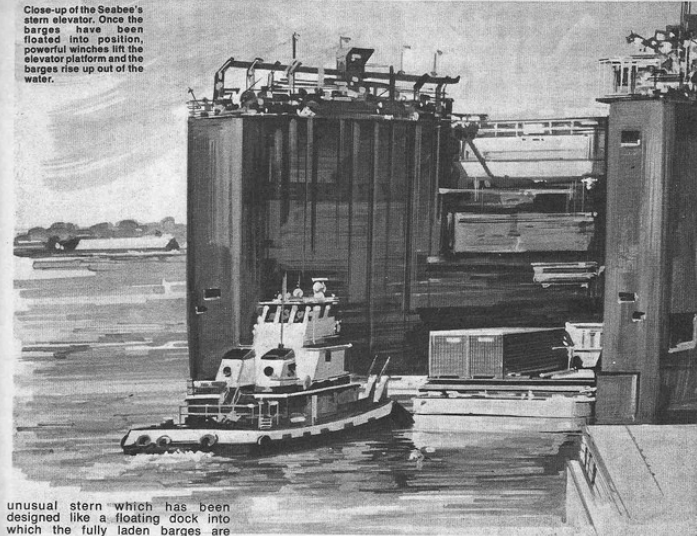
Where the 'mother' Seabee differs from any other ship ever built is in her

**CONTINUED ON NEXT PAGE**



Cutaway of the Seabee carrier which can be loaded in a little over 12 hours with a cargo of 20,000 tons. Barges are raised by the elevator at the stern and conveyed to their stowage positions.

Close-up of the Seabee's stern elevator. Once the barges have been floated into position, powerful winches lift the elevator platform and the barges rise up out of the water.

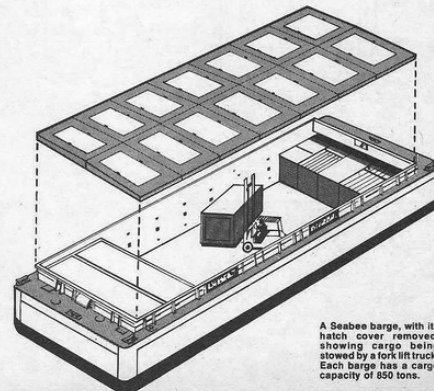


unusual stern which has been designed like a floating dock into which the fully laden barges are nudged by the tugs. The bottom of this stern 'dock' is actually a giant elevator platform suspended from six powerful hydraulic winches, and once the barges have been floated into position the winches lift the platform, and the barges slowly rise out of the water.

The elevator can be stopped level with one of the three vast decks which contain more than three-and-a-half miles (nearly 6 km.) of single-lane highway, and the barges are then ready to be moved into place for making the voyage. The elevator is capable of raising up to 2,000 tons at one go, at a speed of four feet (1.2 m.) a minute. Inside the hull of the Seabee, the cargo officer with his finger-tip control console summons up two huge multi-wheeled transporters which carry the barges to their final positions.

A typical full cargo of around 20,000 tons can be handled in a little over 12 hours by a few skilled seamen on the Seabees.

Once at sea, the Seabees' 36,000 hp steam turbines can power it along at speeds up to 20 knots (22.5 mph — or over 35 kmh.) enabling them to make the journey to Europe in about ten days. Then, within 24 hours they can be refuelled and reloaded ready for the return voyage.



A Seabee barge, with its hatch cover removed, showing cargo being stowed by a fork lift truck. Each barge has a cargo capacity of 850 tons.



# FLYING INTO THE FUTURE

**M**ODERN transport aircraft have progressed at a fantastic rate. Fifty years ago, civil transports flew at only 100 mph. Today, they fly at 600 mph and military aircraft reach speeds of up to 1,800 mph or more. This has been made possible, to a large extent, by the development of a new type of power plant—the turbo-jet engine.

Even this may be out of date 30 years from now when rocket propulsion takes over. However, the day that families orbit the earth is a long way off. But it has become closer with the design of a shuttle craft which may become the first aerospace liner.

The American Boeing Company which has designed it sees it as a pick-a-back arrangement of a jet plane launched into space on the back of a rocket.

The carrying stage would be the size of a 747 Superjet. It would be launched as a rocket booster and would lift the passenger-carrying or freight-carrying stage out of the atmosphere. You

can see this method in the pictures at the top of the facing page.

Once out of the earth's atmosphere, the carrying stage (or booster) would shrug itself clear of the passenger stage and return to earth.

The upper stage with its 50 passengers would continue in orbit, giving the travellers an astronaut's eye-view of the world.

After this, it would return to an airport landing. "We expect the first shuttle to fly into space and back after a shorter development period than we took on the Saturn 5 space booster," said an American expert. "Thereafter, I would expect regularly scheduled flights during the remainder of the next decade."

It is possible, he feels, that within 15 years, normally healthy men and women will fly into orbit and back again with greater ease and frequency than do today's trained and superbly conditioned astronauts.

The space shuttle promises to be a vast improvement over man's present modes of space travel. Today's one-shot boosters are very expensive. They must be launched over water to avoid the danger of spent casings falling on populated areas. And they are very limited in contrast to aeroplanes.

## Startling plan

The services of hundreds of men and machines are required for launching and recovering the space craft crews. In short, despite their incredible performance, today's boosters and space craft have much room for improvement.

America is also planning a supersonic helicopter capable of flying at 1,000 mph and flights in this may be possible in the 1980s.

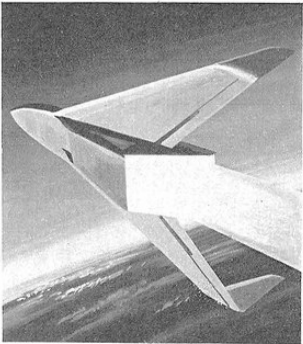
Even before this, another startling development is planned. This is a space station which may be in orbit by the end of 1972. It will be manned by three astronauts who will stay in space for about a month, before returning to earth in a space capsule.

It is thought that by the 1980s, these orbiting stations will be able to hold 50 men. Among other things, they will have gymnasiums in which the crew can keep fit.

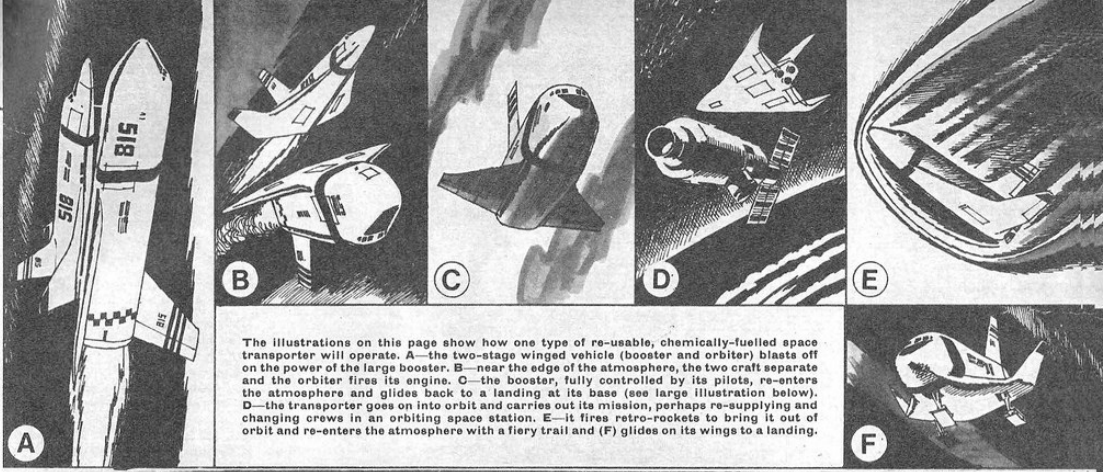
N.A.S.A., the American space agency, plans to operate a 12-man earth-orbiting station. This will last for 10 years, and each crew will stay in it for six months at a time. They will fly to the station and back in space vehicles which can be used again.

Much research is also being done into designing vehicles capable of speeds even greater than those of the supersonic vehicles. Sound takes less than five seconds to travel a mile. The new vehicles are called hypersonic (*hyper* = exceeding; *sonic* = sound) and their speeds may be between 3,960 mph and 7,920 mph.

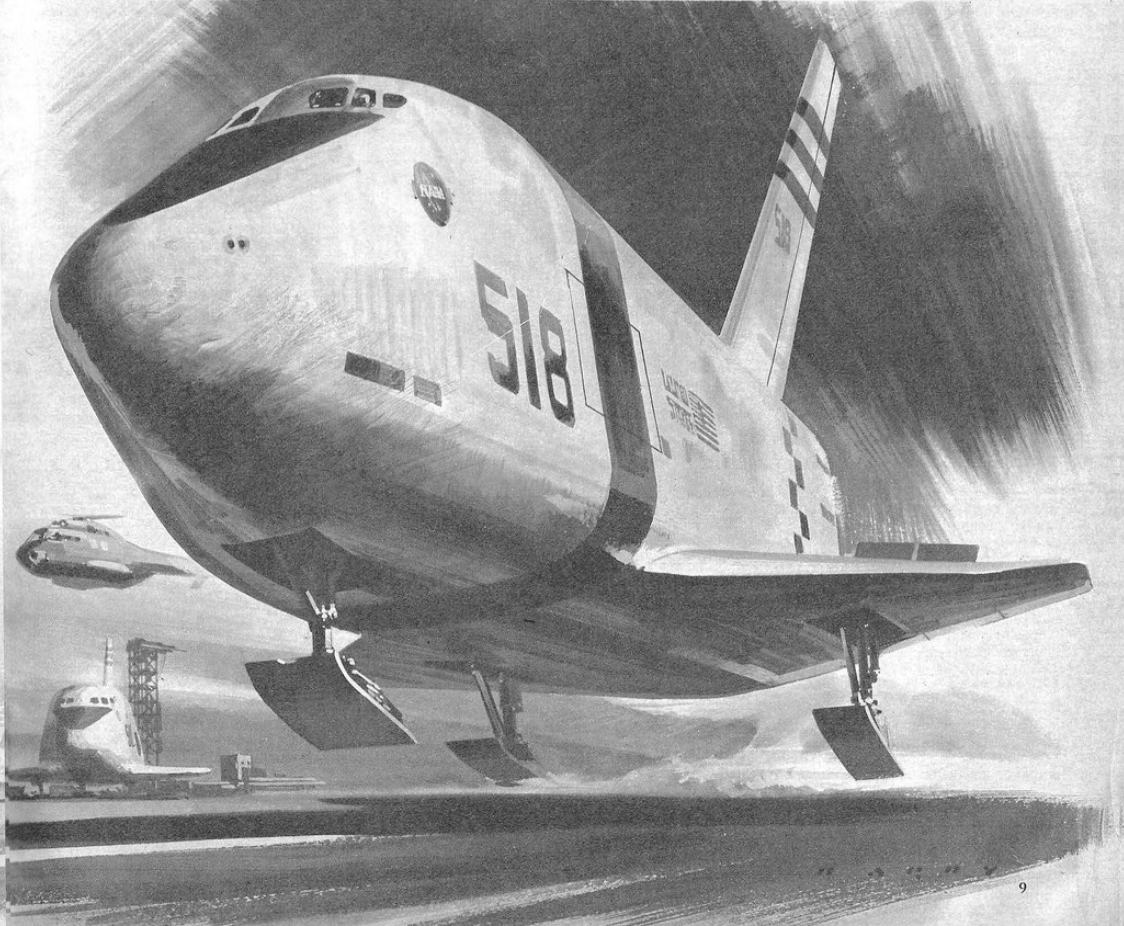
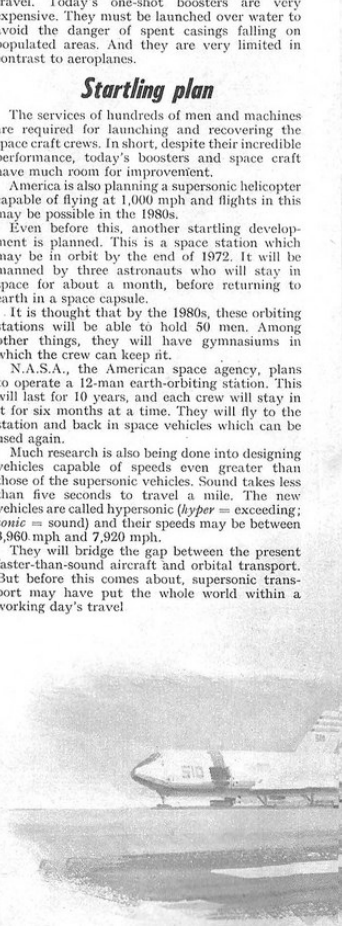
They will bridge the gap between the present faster-than-sound aircraft and orbital transport. But before this comes about, supersonic transport may have put the whole world within a working day's travel



Two visions of the future! Left: a projected design for a hypersonic airliner capable of sub-orbital flight around the world. Such vehicles would fly at between five and ten times the speed of sound. Below: an American engineer shows the paper-thin jet slots in an experimental rotor blade being studied for possible use in 1,000 mph helicopter designs. After take-off, the rotors fold into a single, fixed wing for jet propulsion.



The illustrations on this page show how one type of re-usable, chemically-fuelled space transporter will operate. A—the two-stage winged vehicle (booster and orbiter) blasts off on the power of the large booster. B—near the edge of the atmosphere, the two craft separate and the orbiter fires its engine. C—the booster, fully controlled by its pilots, re-enters the atmosphere and glides back to a landing at its base (see large illustration below). D—the transporter goes on into orbit and carries out its mission, perhaps re-supplying and changing crews in an orbiting space station. E—it fires retro-rockets to bring it out of orbit and re-enters the atmosphere with a fiery trail and (F) glides on its wings to a landing.





# FLYING INTO THE FUTURE

A series which explores the wonders of modern aviation

by PETER DUNCAN



## SPEEDING GIANTS!

**T**HROUGHOUT the world, international airports are reaching the limit of the number of planes and passengers they can handle. In New York, at peak times, delays of up to three hours are not unusual at both take-off and landing.

By 1980, Sydney is likely to be only ten hours away from London. The growth of air transport will bring air travel within the reach of many more millions of people. In the next ten years, it is estimated that passengers on the world's scheduled airlines could reach 1,000 million in a year. In Britain alone, vast increases in the number of passengers are forecast—by 1980 the flying population will be over 53 million a year, almost equal to our total population.

Speeds will double to more than 1,300 m.p.h. Today, normal cruising speeds are around 600 m.p.h.—the world's air speed record of 1949. It is quite clear that commercial aviation's most serious problem today is the continuous increase in air traffic.

If this problem is not solved, costs will soar, the advantage of speed in the air will be lost, and, worst of all, air safety is likely to be prejudiced.

### How will these problems be solved?

The six largest traffic centres in the world—Chicago, New York, Miami, Los Angeles, San Francisco and London—will eventually each require probably four major airports (each with four main runways) grouped around it to meet the requirements of the future. These multiple-airports would be placed so that nobody would have to travel too far to get to the nearest airport.

With such a pattern, each of these major airports would be able to accommodate, without delays or congestion, approximately one million

aircraft movements a year. That means, perhaps, that they would handle 40 million passengers a year as a normal operation. So, four airports would together provide a comfortable capacity for four million aircraft movements a year and 160 million passengers a year.

It is intended that no airport should be more than thirty-five miles from a city centre. Surface journey times much in excess of forty-five minutes to and from airports will not be acceptable in the supersonic era. An international airport handling 75 million passengers a year would need colossal road transport facilities, and it has been established that even with a city centre-airport transit system carrying 50 per cent of the air passengers, the peak flow of road vehicles taking air travellers and airport employees to and from the airport might be 11,000 an hour. This volume of traffic would make it necessary to build 10-lane roads in each direction. From

this it can be seen that for people who live anywhere near a proposed new airport site, a major upheaval would be inevitable.

London's third airport has still to be chosen. The delay has been caused by opposition by communities to the siting of the airport—destruction of beautiful scenery and farmland, as well as perhaps the biggest problem of all, aircraft noise. As a new airport costs something like £100 million, many people believe that this money would be better spent on reclaiming land for a remote site such as Foulness Island, but others argue that it would be better spent on designing new engines or soundproofing existing ones.

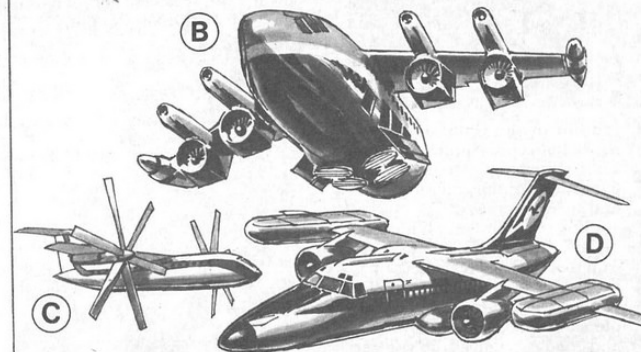
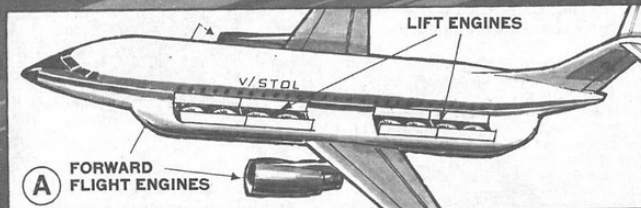
British European Airways, the biggest user of London's Heathrow Airport, say that a third London airport will not be necessary for another fifteen years. New developments in S.T.O.L.—Short Take-off and Landing aircraft—could be introduced in Britain within five years. British aircraft manufacturers think that vertical and short take-off planes carrying 100 to 200 passengers could be servicing routes of up to 500 miles by 1979.

Plans for a 120-seater jet airliner that will take-off vertically and fly at 600 m.p.h. have been announced by British Hawker-Siddeley. The H.S. 141 could enter service in the 1980s. It will have a range of 500 miles, or, if used for short take-off, it would have a range of 1,350 miles and only need a 1,000-foot runway. Government experts predict that vertical take-off aircraft could carry 16 million passengers a year, using only a small corner of Heathrow Airport. All these various arguments have to be considered, and a decision for the international airports of the 1980s must be reached quickly.

The British Airports Authority has an unenviable task, but their chairman says, "I look forward to the day when it will be possible to travel comfortably from any place on earth to any other in the space of a couple of hours—of which half will, inevitably, be taken up in getting to and from the airports or launching pads.

"I look forward to the day when all aircraft are 'whispering giants' of quietness.

"And I look forward to the day when—in the fullness of time—'the air faring outlook' is as widespread and as welcome as was the sea faring outlook in days gone by. The one made our nation great in former times. I'm sure that the other can maintain that greatness in the years ahead."



Are these the airliners of the 1980s? All these projects are V/STOL designs (Vertical/Short Take-off and Landing). At the top is shown the superbly graceful Hawker Siddeley HS. 141 (A). Its propulsion system comprises up to 16 Rolls-Royce lift fans in two jutting side sponsons with hinged air intake doors and two powerful podded underwing engines to be based on the RB 211 engine design. The lift engines give a short, steep take-off and landing while the conventional engines give high speed forward flight. At (B) is the German Messerschmitt-Boelkow-Blohm consortium's HFB-600 Vertibus. It uses four turbojets in slim pods to spin large fans. The fans' thrust (from the rear of their box-like nacelles) is directed by guide vanes to give V/STOL or horizontal flight. The Westland WG 22 "lift wing" design (C) uses two huge six-blade rotors. The Dornier DO 231 (D) uses separate lift and forward thrust engines. Twelve Rolls-Royce RB 202 lift engines are mounted in long wing-pods.

An all-too familiar scene at many of America's congested big airports . . . a queue of big jets awaiting their turn for clearance to turn on to the runway for take-off.







Helping to pave the way for a new generation of aircraft that will take-off and land vertically, this German VAK-191B makes use of not one but three jet engines to give it that extra "get-up and go!"

# Jumping jets!

THE virtues of an aircraft which can take-off and land vertically have been recognised by military and commercial air specialists for a long time. These aircraft can operate from hastily prepared clearings in jungles or forests, from the flat roofs of large buildings and from small platforms on almost any type of ship, yet they are capable of flying at high speed and delivering a formidable blow to an enemy in terms of firepower.

Britain's Hawker Siddeley Harrier was one of the first military Vertical/Short Take-off and Landing (V/STOL) aircraft to go into operational service, making use of this flight principle very successfully. Now Germany, in collaboration with Italy, has produced its first V/STOL aircraft — the VAK-191B.

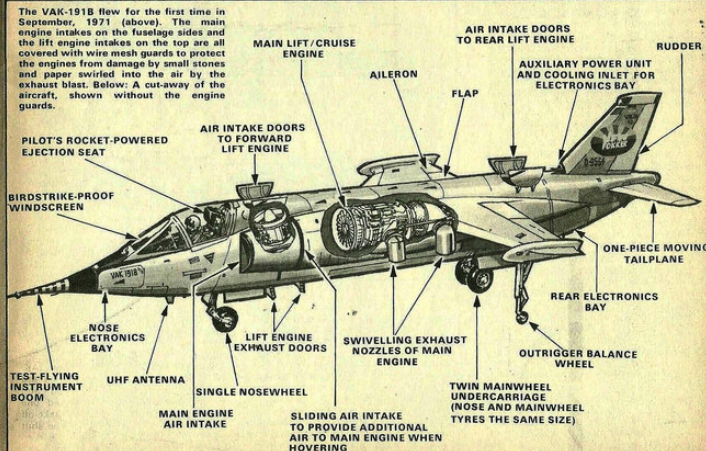
Unlike the Harrier, which has one main engine with swivelling or vectored exhausts that turn during the transition from upward to forward flight, the VAK-191B makes use of three engines. The main engine in the middle of the fuselage provides normal flight power as well as

about 50 per cent of the lift needed for vertical take-off. The other half of the power for take-off only is provided by two smaller lift engines mounted fore and aft. These are mounted about 12½ degrees to the vertical so should the main engine be damaged during a mission, the slight amount of forward propulsion they provide could be used as a "get-you-home" measure by the pilot.

Once the VAK-191B is airborne and in normal forward flight the two lift engines are "shut down" and only the lift/cruise engine is used, giving the aircraft much better fuel economy than the Harrier.

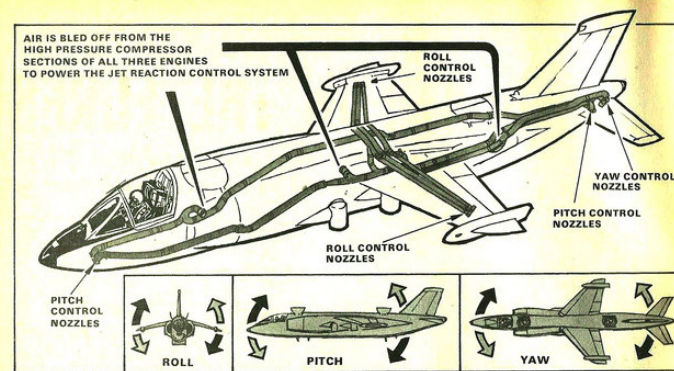
Both the small lift engines in the VAK-191B are controlled by one throttle and their performance is monitored and compared continuously so should one engine lose power in the crucial take-off or landing period, the other will be shut down immediately to prevent a dangerous imbalance of thrust.

To manoeuvre, an aircraft needs an



The VAK-191B flew for the first time in September, 1971 (above). The main engine intakes on the fuselage sides and the lift engine intakes on the top are all covered with wire mesh guards to protect the engines from damage by small stones and paper swirled into the air by the exhaust blast. Below: A cut-away of the aircraft, shown without the engine guards.

AIR IS BLED OFF FROM THE HIGH PRESSURE COMPRESSOR SECTIONS OF ALL THREE ENGINES TO POWER THE JET REACTION CONTROL SYSTEM



airflow over the control surfaces of its wings and tailplane but when a V/STOL aircraft takes-off or lands this airflow is non-existent. To counteract this the aircraft is fitted with a jet reaction control system which bleeds off high pressure air from all three engines and ducts it to nozzles in the wing tips, tail and nose of the aircraft. The system is controlled by the pilot's stick and rudder controls which "puffs" out air to a greater or lesser degree from the nozzles, thereby controlling the roll, pitch and yaw of the aircraft and keeping it steady until enough forward speed has been achieved to fly the aircraft normally.

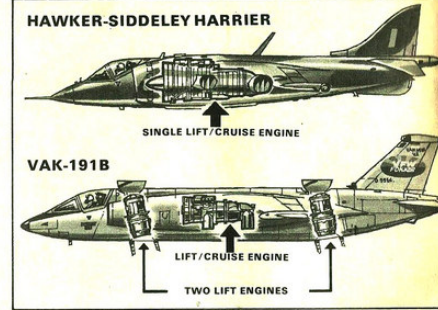
## FLYING BY WIRE

A mission in the VAK-191B, which is designed for bombing, reconnaissance and ground attack, would begin with the starting of the main lift/cruise engine. During ground running the forward section of each lift/cruise engine intake is slid forward about 10 inches making a slot through which some 70 per cent of the air needed for the main engine flows. Ducts in the top and bottom of the fuselage are then opened and the fore and aft lift engines are started. Once the aircraft has taken off and moved into horizontal flight, the two lift engines are stopped and the ducts closed.

The aircraft controls are worked electrically, movements on the control column and the rudder pedals sending electric signals to the power units that control the wings and rudder. In the event of a total electrical failure there is also a mechanical system to fly the aircraft.

Once the aircraft has performed its mission it returns to base and landing the pilot opens the upper and lower fuselage ducts. Air flowing past the lower lift engine ducts creates a low pressure area, inducing a flow of air

Above: For control in flight an aircraft needs airflow over its wings and tail. When a V/STOL aircraft is going up or down no airflow exists, so a "puff-jet" reaction control system operates through the pilot's control column and rudder pedals, blowing high pressure air from the wing tips, tail and nose to keep the aircraft stable. Below: Comparison between the power units of Britain's Harrier "jump-jet" and the German VAK-191B.



through the upper ducts that spins the turbine blades of the lift engines and starts them up in time for the vertical landing.

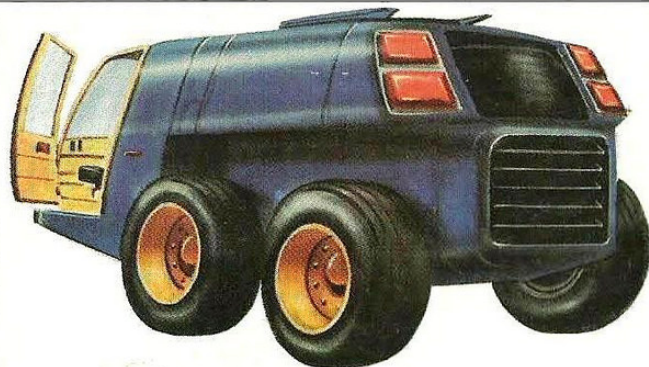
The VAK-191B flew for the first time in September, 1971, ten years after the first design studies had been made. If this seems a long time for an aircraft to take-off from the drawing board it must be remembered that many problems had to be overcome in this untried system of take-off and landing. Originally the aircraft was to play a major role in NATO's plan for the defence of Europe, but over

the years the role of "limited mission" planes has been replaced with a desire to have a "Multi-Role Combat Aircraft" (MRCA) — a general purpose aircraft that can carry out all the military roles required for defence.

It now looks as though the VAK-191B will not go into operational service. Instead it might become a flying "test-bed" for the next generation of V/STOL "swing-wing" aircraft and will provide much valuable information for future "jump-jet" programmes, both commercial and military.

CONTINUED ON NEXT PAGE





Rear view of the tractor unit. Incorporated are an anti-jack-knife coupling, spare wheel stowage, rear light cluster and an air intake.



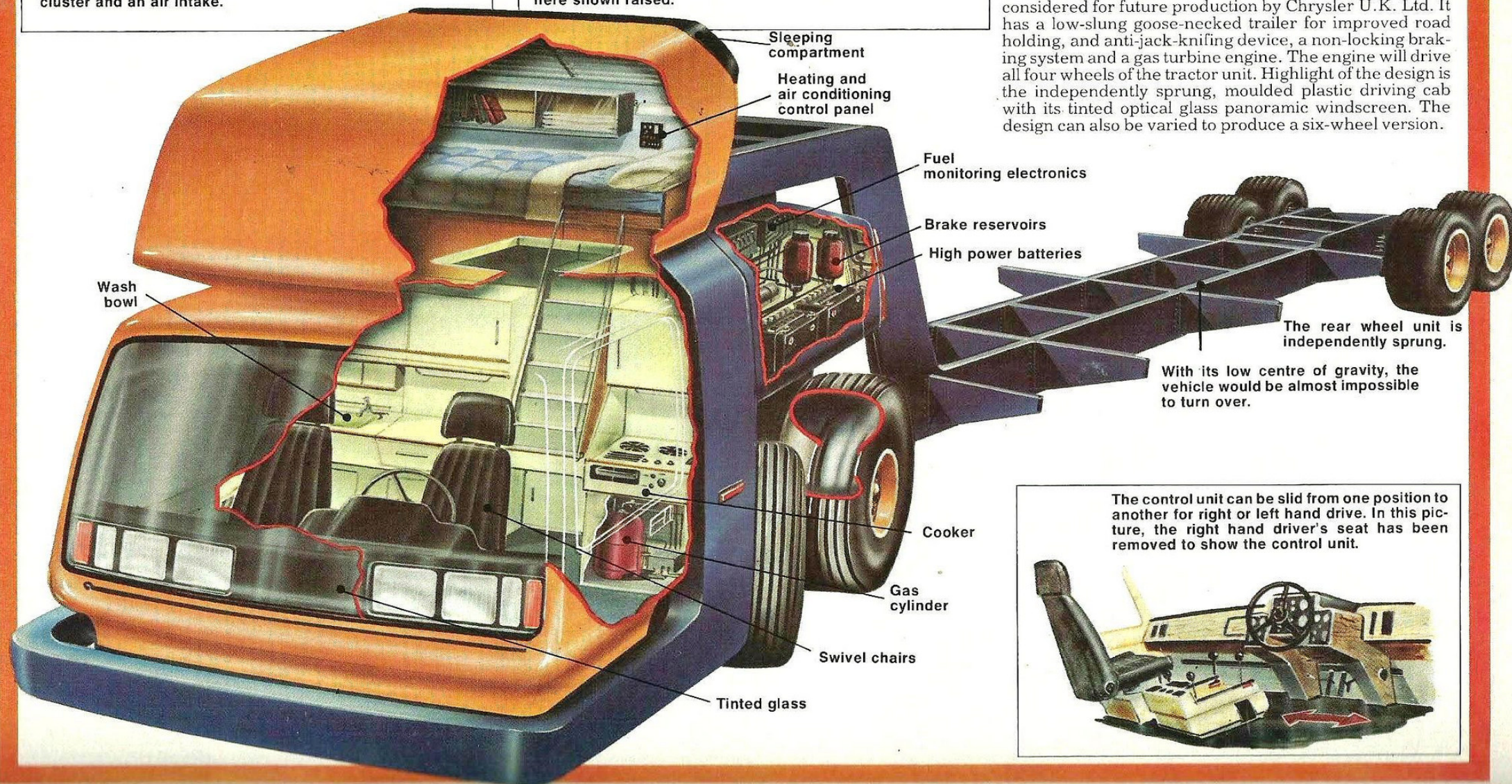
Front view. The power unit is a longitudinal gas turbine engine which can be unbolted and replaced in two hours. In this picture, the cab is fully jacked up, showing how an engine-change could be made. The hinged inspection grill is here shown raised.

## INSIDE STORY

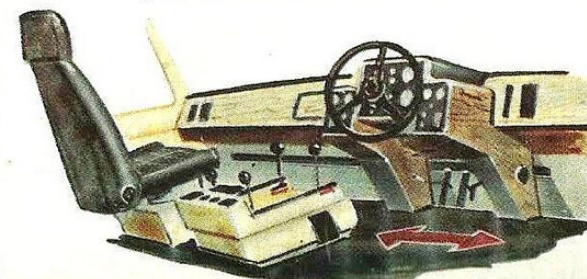
# Lorry Of The Future

**A fast, safe articulated vehicle — a super-artic — is destined for the roads of tomorrow**

Safer and more reliable than any similar vehicle on the road — that is the claim made for the articulated lorry shown on this page. Still in the design stage, it is being considered for future production by Chrysler U.K. Ltd. It has a low-slung goose-necked trailer for improved road holding, and anti-jack-knifing device, a non-locking braking system and a gas turbine engine. The engine will drive all four wheels of the tractor unit. Highlight of the design is the independently sprung, moulded plastic driving cab with its tinted optical glass panoramic windscreen. The design can also be varied to produce a six-wheel version.



The control unit can be slid from one position to another for right or left hand drive. In this picture, the right hand driver's seat has been removed to show the control unit.





# SAUCERS UNDER THE SEA

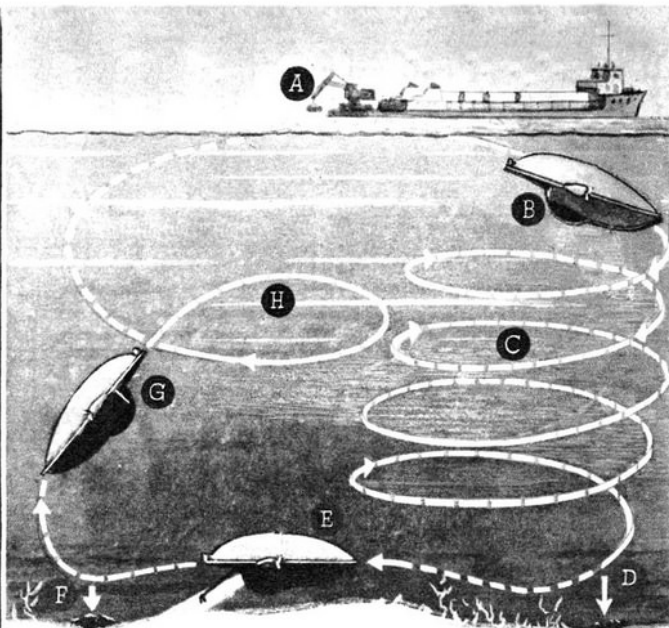
**U**NDERWATER exploration of the world's oceans has become a day-to-day reality. Oceanography, often called 'Inner Space', is becoming a science priority and exciting developments are to come. The world-wide need for more food, much of it to come from the sea, and the exploration of the sea's minerals, will forward more research in oceanography.

The Royal Navy has recently become interested in two American designs of diving saucers, one a small 'runabout' to carry two men on observation trips down to a depth of 1,000 feet and a longer one called *Deepstar* - an 8-ton revolutionary underwater search and rescue diving vehicle now in production.

*Deepstar*, shown here in cutaway form, carries three men and can dive to 4,000 feet for about 24 hours' duration, moving around at 3 knots by means of two outside propellers driven by 4½ h.p. electric motors. A hydraulic-controlled claw can pick up objects from the sea bed. The crew and a mass of instruments are inside a spherical steel pressure hull 1½ ins. thick. The outside fairing carrying various accessories - ballast weights, etc. - is made of fibre-glass and is free flooding, so that the water is the same pressure inside and outside.

A number of *Deepstars* may be positioned around the world, so that no matter where a submarine mishap occurs, help can be supplied quickly.

A 3½-ton diving saucer or 'run-about'. The submarine is driven by outside water jets at a speed of 1 knot. Diving depth is 1,000 feet



## METHOD OF OPERATION

(A) Surface handling crane on operations ship. (B) Descent position with ballast weights. (C) Spiral descent path. (D) At desired operational depth, ballast weights are dropped. (E) Movement forward or aft, using propellers - pitch control by mercury cylinders. (F) Forward ballast weights dropped for ascent. (G) Ascent position. (H) Spiral ascent path.



## KEY TO DEEPSTAR

(1) Descent weights that can be dropped. (2) Water ballast spheres. (3) Port propulsion motor and propeller. (4) Inverter for electric motors. (5) Aft mercury cylinder for pitch control. (6) Radio antenna. (7) Hydraulic connections between mercury cylinders. (8) Steel pressure hull, 6½ feet in diameter. (9) Inflatable canvas conning tower for exit on surface. (10) Entrance hatch. (11) Fibre-glass free-flooding fairing. (12) Electronic depth indicator. (13) Instrument panel for directional gyroscope, oxygen flow controls, weight release, two-way surface radio, two-way underwater telephone, etc. (14) Sea-bed depth sounder. (15) Crewman in prone position for observation. (16) Viewing light. (17) Crewman in prone position. (18) Motion picture camera. (19) Batteries (can be dropped). (20) Forward mercury cylinder for pitch control. (21) Telescopic 2,500-watt light for motion picture camera work. (22) Ascent weights that can be dropped. (23) Viewing light. (24) Observation ports. (25) Hydraulic-controlled claw.

AN EAGLE  
cutaway  
DRAWING

ASHWELL  
L'WOOD



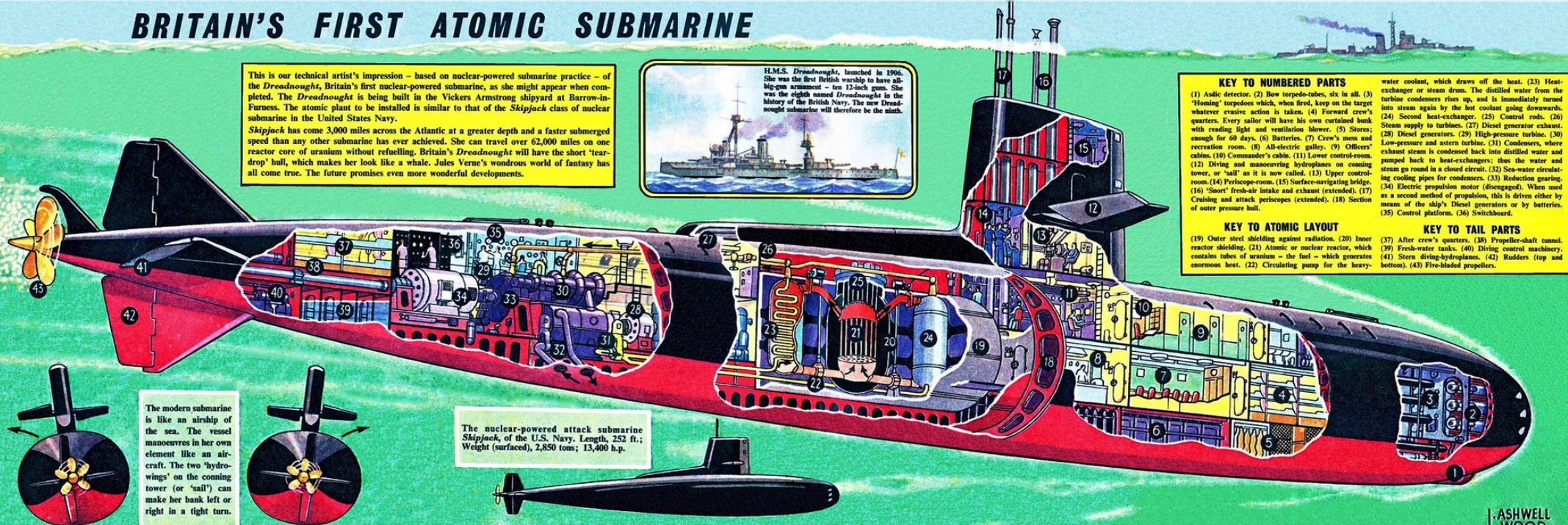
# BRITAIN'S FIRST ATOMIC SUBMARINE

This is our technical artist's impression - based on nuclear-powered submarine practice - of the *Dreadnought*, Britain's first nuclear-powered submarine, as she might appear when completed. The *Dreadnought* is being built in the Vickers Armstrong shipyard at Barrow-in-Furness. The atomic plant to be installed is similar to that of the *Skipjack* class of nuclear submarine in the United States Navy.

*Skipjack* has come 3,000 miles across the Atlantic at a greater depth and a faster submerged speed than any other submarine has ever achieved. She can travel over 62,000 miles on one reactor core of uranium without refuelling. Britain's *Dreadnought* will have the short 'tear-drop' hull, which makes her look like a whale. Jules Verne's wondrous world of fantasy has all come true. The future promises even more wonderful developments.



H.M.S. *Dreadnought*, launched in 1906. She was the first British warship to have all-big-gun armament - ten 12-inch guns. She was the eighth named *Dreadnought* in the history of the British Navy. The new *Dreadnought* submarine will therefore be the ninth.



## KEY TO NUMBERED PARTS

(1) Asdic detector. (2) Bow torpedo-tubes, six in all. (3) 'Homing' torpedoes which, when fired, keep on the target whatever evasive action is taken. (4) Forward crew's quarters. Every sailor will have his own curtained bunk with reading light and ventilation blower. (5) Stores; enough for 60 days. (6) Batteries. (7) Crew's mess and recreation room. (8) All-electric galley. (9) Officers' cabins. (10) Commander's cabin. (11) Lower control-room. (12) Diving and manoeuvring hydroplanes on conning tower, or 'sail' as it is now called. (13) Upper control-room. (14) Periscope-room. (15) Surface-navigating bridge. (16) 'Snort' fresh-air intake and exhaust (extended). (17) Cruising and attack periscopes (extended). (18) Section of outer pressure hull. (19) Asdic detector. (20) Bow torpedo-tubes, six in all. (21) 'Homing' torpedoes which, when fired, keep on the target whatever evasive action is taken. (22) Forward crew's quarters. Every sailor will have his own curtained bunk with reading light and ventilation blower. (23) Stores; enough for 60 days. (24) Batteries. (25) Crew's mess and recreation room. (26) All-electric galley. (27) Officers' cabins. (28) Commander's cabin. (29) Lower control-room. (30) Diving and manoeuvring hydroplanes on conning tower, or 'sail' as it is now called. (31) Upper control-room. (32) Periscope-room. (33) Surface-navigating bridge. (34) 'Snort' fresh-air intake and exhaust (extended). (35) Cruising and attack periscopes (extended). (36) Section of outer pressure hull. (37) After crew's quarters. (38) Propeller-shaft tunnel. (39) Fresh-water tanks. (40) Diving control machinery. (41) Stern diving-hydroplanes. (42) Rudders (top and bottom). (43) Five-bladed propellers.

## KEY TO ATOMIC LAYOUT

(19) Outer steel shielding against radiation. (20) Inner reactor shielding. (21) Atomic or nuclear reactor, which contains tubes of uranium - the fuel - which generates enormous heat. (22) Circulating pump for the heavy-

## KEY TO TAIL PARTS

(37) After crew's quarters. (38) Propeller-shaft tunnel. (39) Fresh-water tanks. (40) Diving control machinery. (41) Stern diving-hydroplanes. (42) Rudders (top and bottom). (43) Five-bladed propellers.

The modern submarine is like an airship of the sea. The vessel manoeuvres in her own element like an aircraft. The two 'hydro-wings' on the conning tower (or 'sail') can make her bank left or right in a tight turn.

The nuclear-powered attack submarine *Skipjack*, of the U.S. Navy. Length, 252 ft.; Weight (surfaced), 2,850 tons; 13,400 h.p.



# A GIANT CONDENSING LOCOMOTIVE

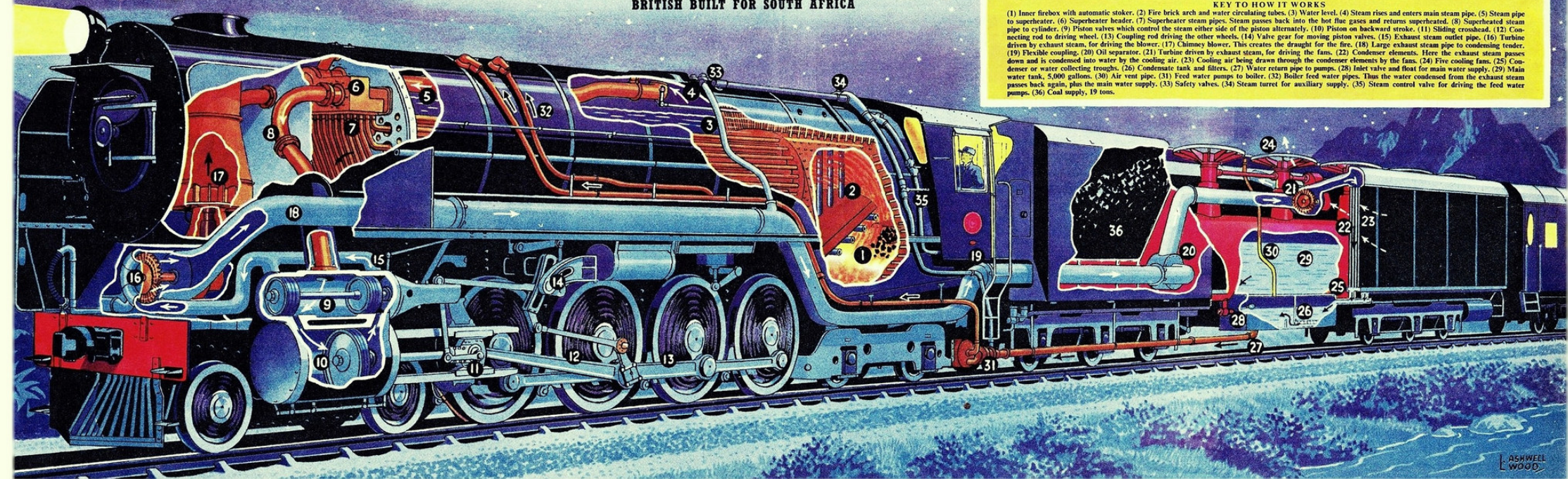
BRITISH BUILT FOR SOUTH AFRICA

These unusual class of locomotives are being built for the South African railways and are among the most powerful in the world on the 3ft. 6in. gauge. They are of the condensing type, that is, they convert their own

exhaust steam back into water, which is used over again in the boiler. The drawing clearly shows how this is done. Known as the class "25" they weigh 230½ tons in working order and are 108ft. long overall.

## KEY TO HOW IT WORKS

(1) Inner firebox with automatic stoker. (2) Fire brick arch and water circulating tubes. (3) Water level. (4) Steam rises and enters main steam pipe. (5) Steam pipe to superheater. (6) Superheater header. (7) Superheater steam pipes. Steam passes back into the hot flue gases and returns superheated. (8) Superheated steam pipe to cylinder. (9) Piston valves which control the steam either side of the piston alternately. (10) Piston on backward stroke. (11) Sliding crosshead. (12) Connecting rod to driving wheel. (13) Coupling rod driving the other wheels. (14) Valve gear for moving piston valves. (15) Exhaust steam outlet pipe. (16) Turbine driven by exhaust steam, for driving the blower. (17) Chimney blower. This creates the draught for the fire. (18) Large exhaust steam pipe to condensing tender. (19) Flexible coupling. (20) Oil separator. (21) Turbine driven by exhaust steam, for driving the fans. (22) Condenser elements. Here the exhaust steam passes down and is condensed into water by the cooling air. (23) Cooling air being drawn through the condenser elements by the fans. (24) Five cooling fans. (25) Condenser or water collecting troughs. (26) Condensate tank and filters. (27) Water return pipe to pumps. (28) Inlet valve and float for main water supply. (29) Main water tank, 5,000 gallons. (30) Air vent pipe. (31) Feed water pumps to boiler. (32) Boiler feed water pipes. Thus the water condensed from the exhaust steam passes back again, plus the main water supply. (33) Safety valves. (34) Steam turret for auxiliary supply. (35) Steam control valve for driving the feed water pumps. (36) Coal supply, 19 tons.



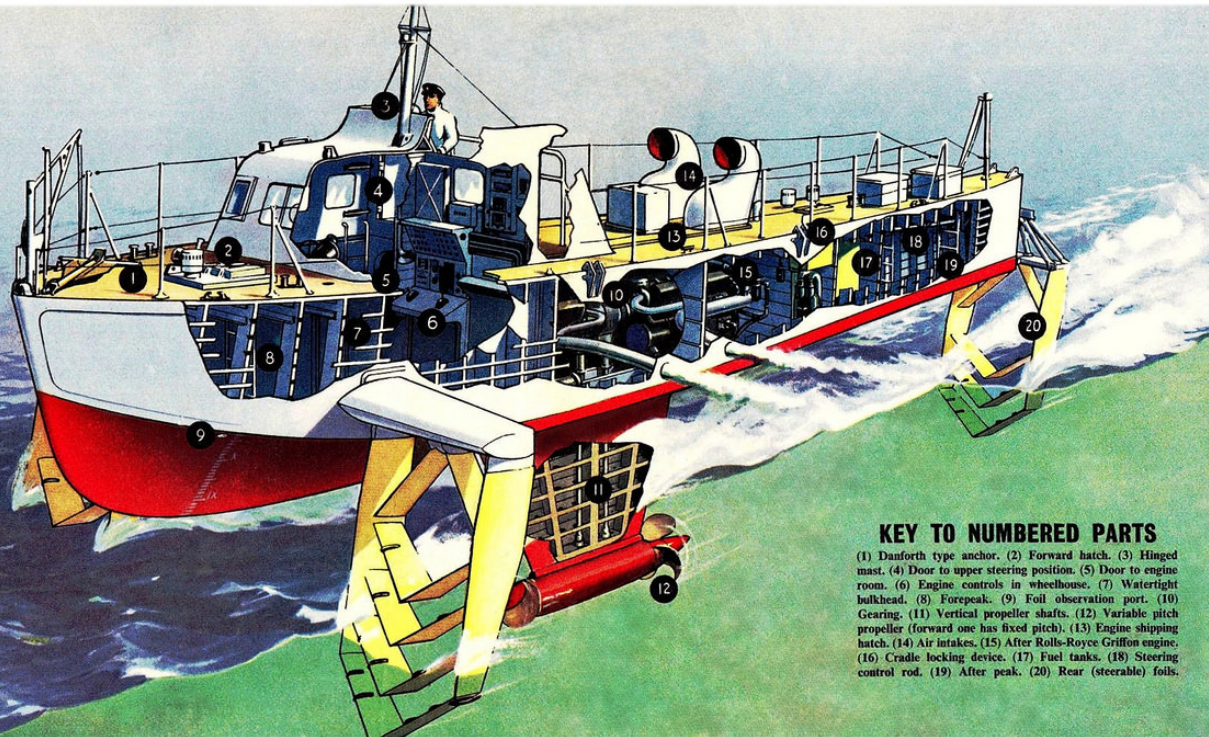
LASHWELL  
WOOD



# THE BRAS D'OR

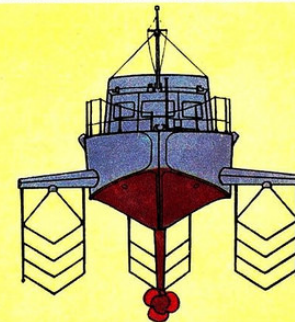
One of the most notable hydrofoil craft yet built is the *Bras d'Or*, completed in 1957 for the Canadian Defence Research Board. Named after a Nova Scotian lake, the scene of earlier hydrofoil tests, the vessel - now being used for research purposes - was designed by Saunders-Roe Ltd. at Cowes, and built at Beaumaris by Saunders-Roe (Anglesey) Ltd. To reduce weight, light alloys and aircraft construction techniques were used for her 59ft.-long hull. She is fitted with three Bell-Baldwin ladder-type hydrofoils, of which the two forward ones are mounted on a 24 ft.-long cross-beam; the after set also acts as a rudder. To present the best angle of attack to varying wave conditions, the 'set' of all foils is adjustable. The *Bras d'Or* is powered by two 1,750 b.h.p. Rolls-Royce Griffon VI aero-engines, and leaves the water at about 20 knots. At maximum speed, the hull is about 3 ft. 6 ins. above the water; this permits high speeds even in rough weather. The hull has five compartments: wheelhouse, engine room, tank space, and fore and aft peaks. From the wheelhouse, doors give access to the outer steering position and to the engine room. The engineer's control position is in the wheelhouse, where a soundproof window gives a clear view of the engines.

No accommodation is provided, as the craft is intended only for daytime use. At base, a special wheeled cradle is used for beaching.



## KEY TO NUMBERED PARTS

(1) Danforth type anchor. (2) Forward hatch. (3) Hinged mast. (4) Door to upper steering position. (5) Door to engine room. (6) Engine controls in wheelhouse. (7) Watertight bulkhead. (8) Forepeak. (9) Foil observation port. (10) Gearing. (11) Vertical propeller shafts. (12) Variable pitch propeller (forward one has fixed pitch). (13) Engine shipping hatch. (14) Air intakes. (15) After Rolls-Royce Griffon engine. (16) Cradle locking device. (17) Fuel tanks. (18) Steering control rod. (19) After peak. (20) Rear (steerable) foils.



The foil arrangement of *Bras d'Or* seen end on. Below, for comparison, are the main foil shapes of some other types. Left to right: Supramar Ferry, Carl Runabout, Carl XCH-4, Hook Runabout and Aquavion.

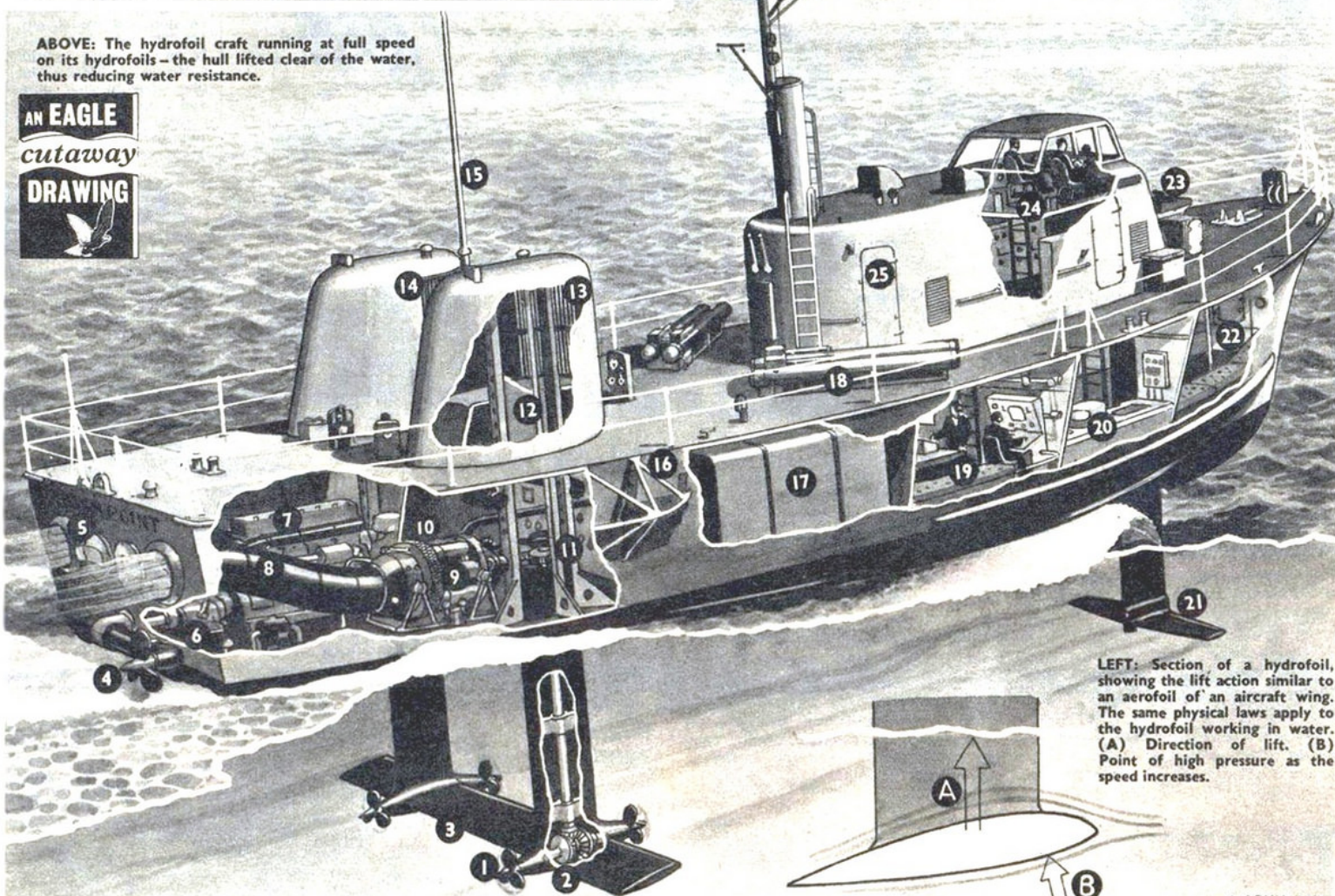




# WARSHIP ON STILTS



ABOVE: The hydrofoil craft running at full speed on its hydrofoils—the hull lifted clear of the water, thus reducing water resistance.

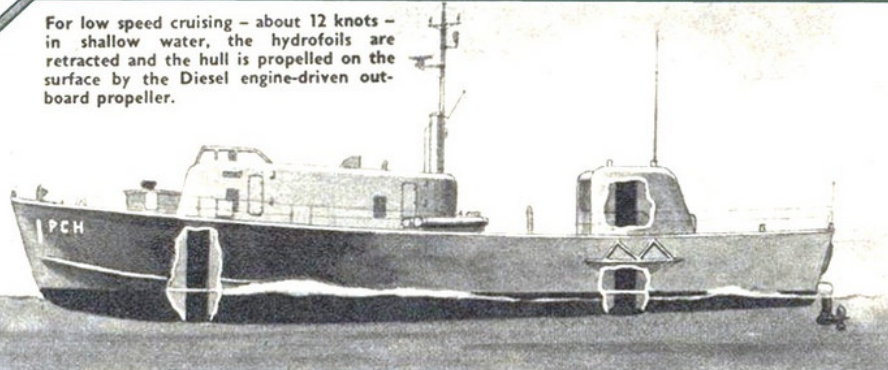


LEFT: Section of a hydrofoil, showing the lift action similar to an aerofoil of an aircraft wing. The same physical laws apply to the hydrofoil working in water. (A) Direction of lift. (B) Point of high pressure as the speed increases.

## KEY TO NUMBERED PARTS

(1) Propellers turning in opposite directions for hydrofoil operation. (2) Drive to propellers. (3) Rear hydrofoil. (4) Diesel engine-powered propeller for low speed (when hull is resting on the water). Propeller is raised clear for hydrofoil operation. (5) Exhaust outlets of gas-turbine engines. (6) Outboard propeller gearbox. (7) 600 h.p. Packard Diesel engine for driving outboard propeller. (8) Starboard jet pipe. (9) Starboard Bristol Siddeley Proteus 3,100 h.p. gas-turbine engine driving hydrofoil propellers. (10) Air duct to engine. (11) Right angle gear drive to propellers. (12) Casing for hydrofoil struts when retracted. (13) and (14) Engine air inlets. (15) Whip radio aerial. (16) Side bumpers protecting rear hydrofoil. (17) Fuel tanks. (18) Anti-submarine guided missile tubes. (19) Operations room. (20) Galley. (21) Front retractable hydrofoil. The craft is shown lifting 'on' the front hydrofoil while accelerating to high speed. (22) Crew's quarters. (23) Guided missile firing sight. (24) Pilot house similar to an aircraft cockpit with engine controls. (25) Entrance to radar room. (26) Radar scanner.

For low speed cruising—about 12 knots—in shallow water, the hydrofoils are retracted and the hull is propelled on the surface by the Diesel engine-driven outboard propeller.



ASHWELL  
WOOD



# OPERATION MOHOLE

Try to imagine a 12-inch model boat of the one illustrated on a window sill on the 12th floor of a building. From the bottom of the model a piece of fuse wire is hanging to the pavement. On the end of the fuse wire is a 16th-of-an-inch-diameter dot. This is the drilling bit.

Put the real ship over the Mohole deep with its drill pipe touching the bottom and you get the same thing on a larger scale. This fantastic feat of scientific exploration was first put under way in 1960, when CUSS I, an ex U.S. navy vessel, was rebuilt into her present form. CUSS I gets her name from the initials of the oil companies paying for the project. They are Continental, Union, Shell and Superior—all interested in drilling through the earth's crust into the mantle, which is the bulk of the earth's volume.

This mantle lies beneath the crust and is 1,800 miles thick. To drill through to it from the land would mean drilling 15-35 miles before getting to the beginning of it. But in some parts of the ocean the crust is only 3 miles thick, and therefore a much easier job—providing a drilling rig can be stationed over the spot without anchors. The only way of doing this is shown in the lower right sketch. The giant outboard engines can make the ship move in any direction to combat winds, tides, waves, etc. Being out of sight of land, it's not possible to get 'fixes' to check position, so sonar buoys are anchored in 3,500 feet of water all round the ship. Signals sent from a transmitter under the bow bounce off these buoys and any change of position is registered on a screen. A touch of the joystick sends her back on station.

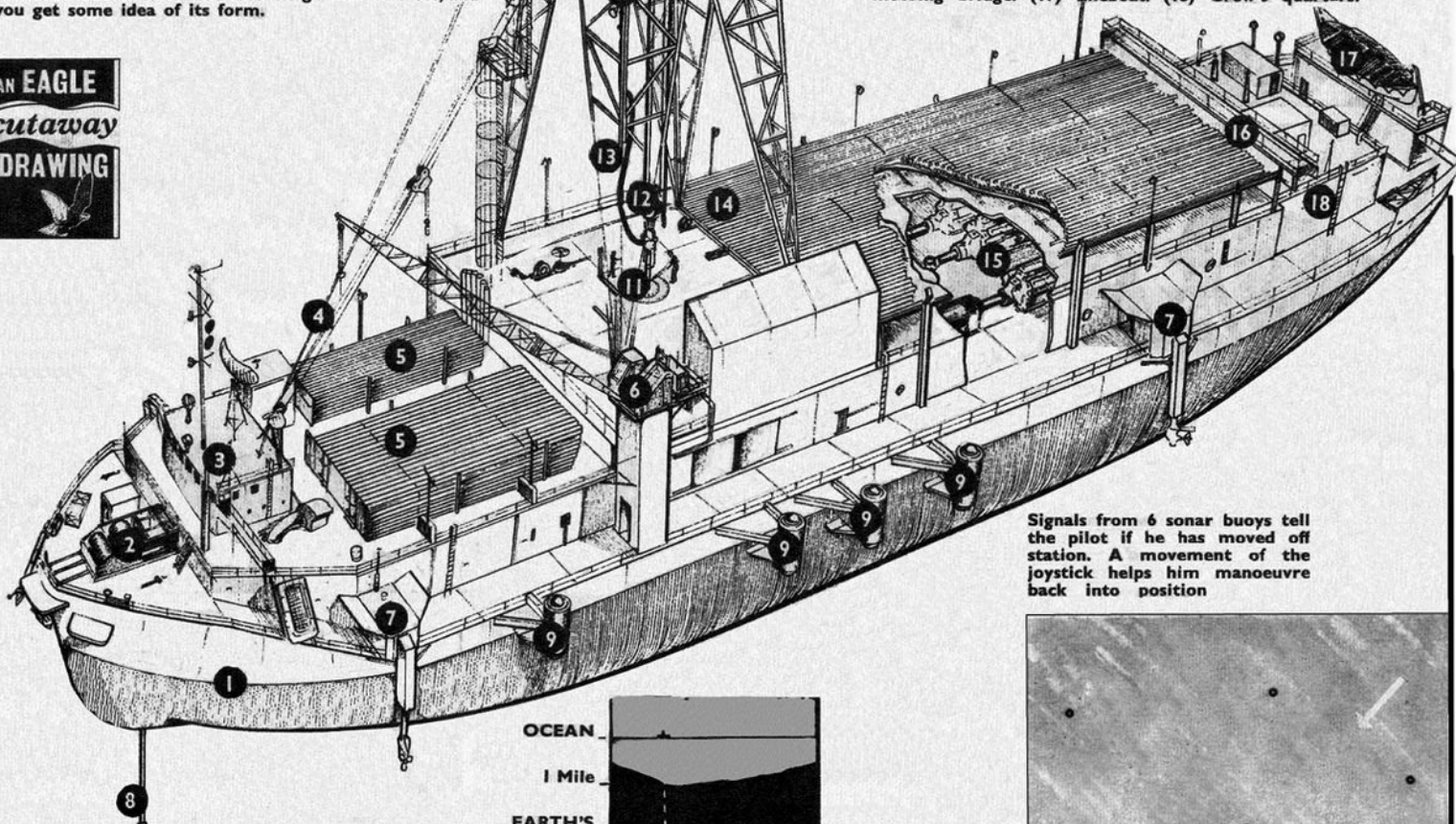
The drill itself is a massive affair. Imagine a doughnut—the type with a hole in the centre—studded with hundreds of industrial diamonds and measuring 9 inches across, and you get some idea of its form.



View of Joystick which, at a touch of the fingers, will send the ship in any direction, including sideways

## KEY TO NUMBERED PARTS

(1) HULL: Length, 260 ft.; beam, 48 ft.; draft, 10 ft.; displacement, 3,100 tons. (2) Mooring winches. (3) Bridge and pilot house. (4) Casing handling highline. (5) 1 mile of casing. (6) Service crane (12-ton capacity). (7) Outboard motors, 2 on port side and 2 on starboard, each powered by a 200 h.p. Diesel engine. (8) Sonar transmitter-receiver. Signals are sent to and received from buoys moored near ship thousands of times a second. (9) Fenders. (10) 100-ft. drilling derrick. Has to be capable of supporting 300 tons of pipe as well as withstanding torque caused by drilling. (11) Circular table, part of which grips drill pipe and turns the whole unit. (12) Block which holds drill in suspension. (13) Mud and water hose. This mixture drops down through pipe to lubricate the £3,000 drill bit which is studded with diamonds—the only material capable of cutting through the hard rock. (14) 2 miles of drill pipe on automatic pipe stacker. (15) 4 turbo-supercharged engines, providing 2,400 h.p. These are the main source of power. 60,000 gallons of fuel oil are carried below decks. 3,500 gallons of lubricating oil are also carried. (16) Aft mooring bridge. (17) Lifeboat. (18) Crew's quarters.

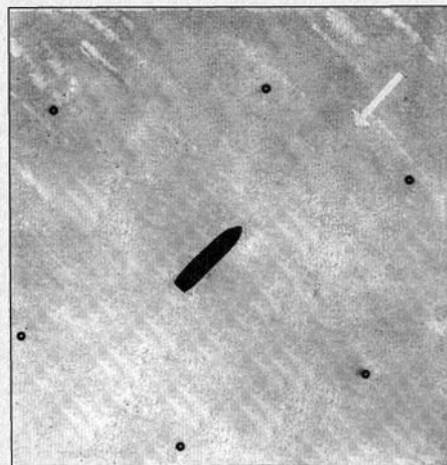
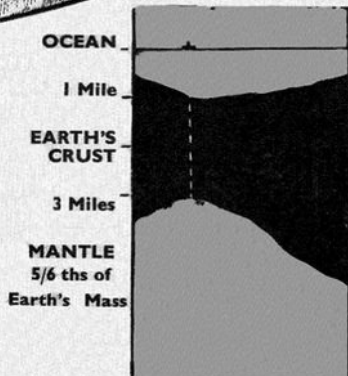


Signals from 6 sonar buoys tell the pilot if he has moved off station. A movement of the joystick helps him manoeuvre back into position

What will be the results of all this research and heavy expenditure? We will know what the earth is made of—most likely there will be a thick layer of meteorites which were attracted to the earth when it was a mass of fire and gases.

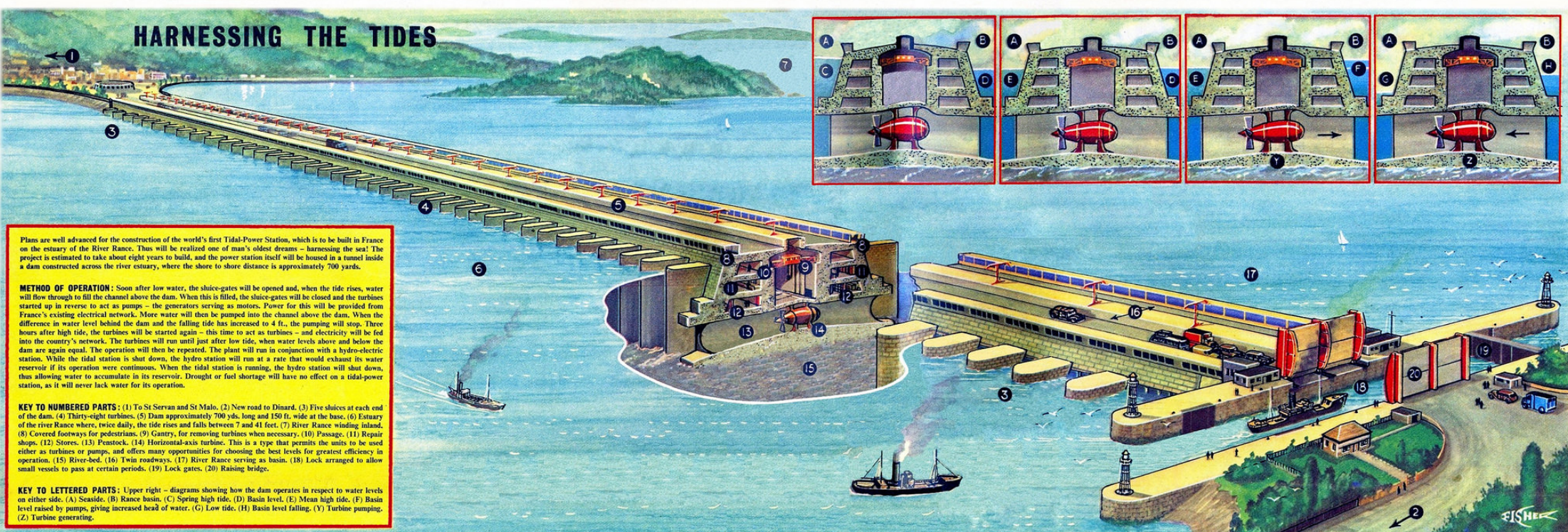
Why do we want to know this? For the same reasons as before, when men dug or drilled into the ground. Sometimes they have found nothing. Other times have produced oil, diamonds, coal, etc. Who knows what this, the greatest drilling project the world has ever known, may reveal?

J. H. Batchelor.





# HARNESSING THE TIDES



Plans are well advanced for the construction of the world's first Tidal-Power Station, which is to be built in France on the estuary of the River Rance. Thus will be realized one of man's oldest dreams – harnessing the sea! The project is estimated to take about eight years to build, and the power station itself will be housed in a tunnel inside a dam constructed across the river estuary, where the shore distance is approximately 700 yards.

**METHOD OF OPERATION:** Soon after low water, the sluice-gates will be opened and, when the tide rises, water will flow through to fill the channel above the dam. When this is filled, the sluice-gates will be closed and the turbines started up in reverse to act as pumps – the generators serving as motors. Power for this will be provided from France's existing electrical network. More water will then be pumped into the channel above the dam. When the difference in water level behind the dam and the falling tide has increased to 4 ft., the pumping will stop. Three hours after high tide, the turbines will be started again – this time to act as turbines – and electricity will be fed into the country's network. The turbines will run until just after low tide, when water levels above and below the dam are again equal. The operation will then be repeated. The plant will run in conjunction with a hydro-electric station. While the tidal station is shut down, the hydro station will run at a rate that would exhaust its water reservoir if its operation were continuous. When the tidal station is running, the hydro station will shut down, thus allowing water to accumulate in its reservoir. Drought or fuel shortage will have no effect on a tidal-power station, as it will never lack water for its operation.

**KEY TO NUMBERED PARTS:** (1) To St Servan and St Malo. (2) New road to Dinard. (3) Five sluices at each end of the dam. (4) Thirty-eight turbines. (5) Dam approximately 700 yds. long and 150 ft. wide at the base. (6) Estuary of the river Rance where, twice daily, the tide rises and falls between 7 and 41 feet. (7) River Rance winding inland. (8) Covered footways for pedestrians. (9) Gantry, for removing turbines when necessary. (10) Passage. (11) Repair shops. (12) Stores. (13) Penstock. (14) Horizontal-axis turbine. This is a type that permits the units to be used either as turbines or pumps, and offers many opportunities for choosing the best levels for greatest efficiency in operation. (15) River-bed. (16) Twin roadways. (17) River Rance serving as basin. (18) Lock arranged to allow small vessels to pass at certain periods. (19) Lock gates. (20) Raising bridge.

**KEY TO LETTERED PARTS:** Upper right – diagrams showing how the dam operates in respect to water levels on either side. (A) Seaside. (B) Rance basin. (C) Spring high tide. (D) Basin level. (E) Mean high tide. (F) Basin level raised by pumps, giving increased head of water. (G) Low tide. (H) Basin level falling. (Y) Turbine pumping. (Z) Turbine generating.



# TOMORROW'S MONSTER CARGO SUB

In 1873, Captain Nemo, in Jules Verne's *Twenty Thousand Leagues Under the Sea*, explained the unlimited range of his submarine *Nautilus*. Today this dream has come true. The atomic submarine can put to sea, driven by an inexhaustible source of power. Not only this, for now designs are going ahead, and tank tests are being made, for a 100,000-ton atomic cargo-carrying submarine as shown on this page.

Submarines of this size are regarded by the experts as a practical proposition, for the bigger they are the more economic they become in terms of atomic power. Moreover the future cargo-submarine would be *unmanned*, 'sensing devices' and remote control taking the place of captain

and crew, except when in harbour,

Underwater *Queen Elizabeths* could be larger and could travel far faster and farther, carrying cargo in special containers to any part of the world - 'trade routes beneath the sea'. The container system of cargo carrying is already being applied to surface ships. The atomic cargo submarine would avoid all the hazards of waves, storms and winds of the surface sea, and, being of great size, could even command underwater speeds higher than the fastest fish.

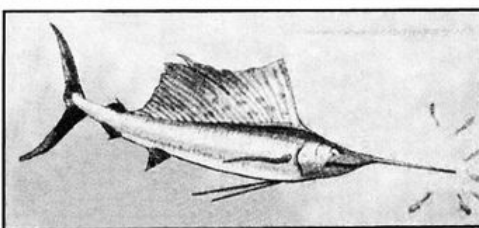
Planned specifications of tomorrow's cargo submarine: length, 960 ft.; beam, 100 ft.; displacement tonnage, 100,000 tons; cargo capacity, 55,000 tons; speed, over 50 knots.

The atomic cargo submarine will be able to circle the world many times without refuelling. Its only stay at home would be a short time in port for cargo handling

Britain's latest Polaris Atomic Submarine *Renown*, 7,500 tons. Length, 425 ft., compared in size with the cargo submarine of the future

## Key to Numbered Parts

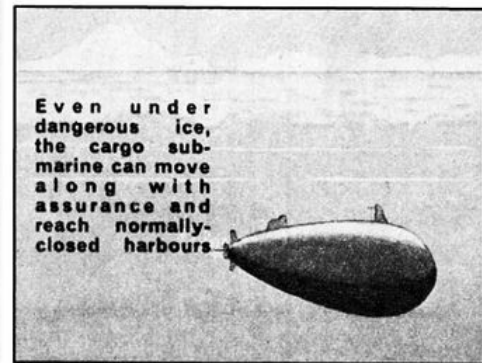
- (1) Single 27-ft.-diameter five-bladed propeller. (2) Steering rudders. (3) Diving rudders or hydroplanes. (4) Propeller shaft. (5) Electric propulsion motor for use as an alternative drive. (6) Motor disengaging clutches. (7) Turbine reduction gearbox. (8) Electronic gear controlling steering and diving rudders. (9) Pressure hull. (10) Low-pressure steam turbine. (11) High-pressure steam turbine. These new-type turbines would develop 120,000 h.p. (12) Condensers. (13) Water from exhaust steam is fed back to reactor - thus steam and water go round in a closed circuit. (14) Circulation pump. (15) Concrete reactor shielding. (16) Electronic controlled steam valves. (17) Atomic core containing tubes of uranium - the almost inexhaustible fuel - which generates enormous heat to supply steam. (18) Reactor compartment. (19) Steam supply to turbines. (20) Outer pressure casing of the Boiling Water Type Atomic Reactor. (21) Reactor access hatch. (22) Reactor can be lifted out and replaced - like a reconditioned engine is fitted to a car. (23) Radar and Sensing control aerials. (24) Conning tower - this would only be used by a crew when in port. (25) Electronic computer room, controlling shut-down of reactor and steam valves. (26) Conveyors for stowing cargo containers. (27) Diving trim tanks. (28) Cargo containers - 60 of these could be stowed and unloaded by conveyors for a quick turn-round in port. (29) Pressurized cargo hatches. (30) Diving tanks. (31) Cargo conveyors. (32) Pressure bulkheads. (33) Cargo containers. (34) Electronic runs to after controls. (35) Forward diving trim tanks. (36) Sensing director. (37) Forward hydroplanes. (38) Sensing and electronic computer control system - the brains of the submarine. As there is no crew, the submarine would be remote-controlled to keep it clear of sea obstructions and guide it on its course. (39) Radar and Sensing control aerials.



The Sailfish, or Swordfish, is reputed to be the fastest thing in the ocean, attaining a speed of 57 miles an hour. This is the same speed as the cargo submarine - about 50 knots.



While surface ships are battling with heavy seas and winds, the cargo submarine goes serenely on its way and need only surface in harbour



Even under dangerous ice, the cargo submarine can move along with assurance and reach normally-closed harbours



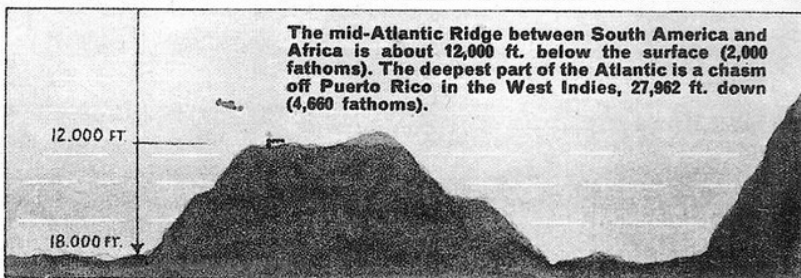
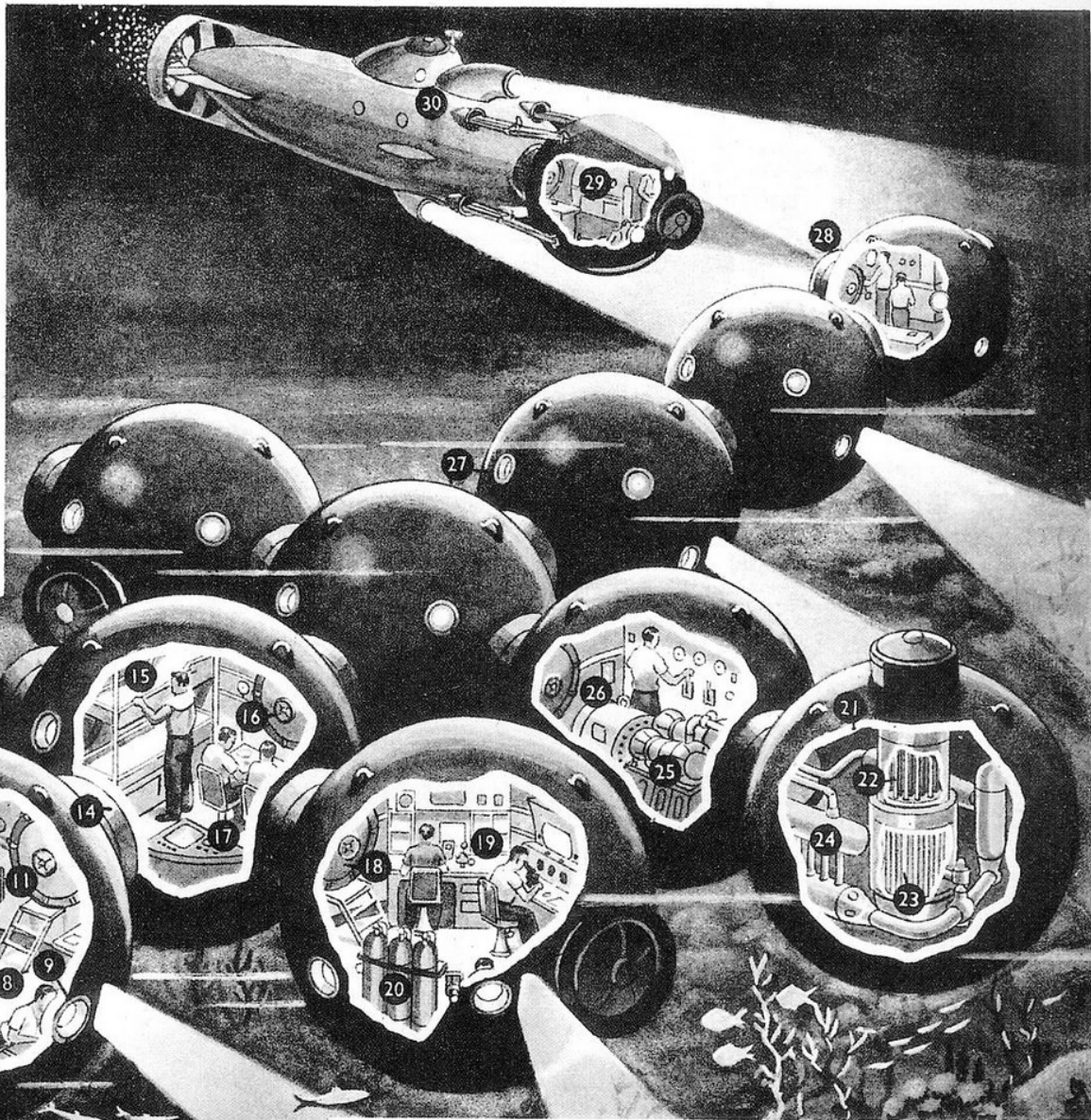
# VILLAGE UNDER THE SEA

**T**HIS underwater 'village' built from a 'kit' should be occupied by 1980. That is the aim of the General Electric Company of America who have planned an underwater research station to be assembled on a site somewhere on the mid-Atlantic Ridge—a chain of mountains under the ocean between South America and Africa. The 'kit' consists of a number of spheres or pressure balls which can be 'plugged' together. These will be taken down 12,000 ft. by special submarines to the top of the ridge, where the first sphere will be anchored to a pillar driven by explosives deep into the sea bed, then the second will be joined to the first, and the other spheres connected to form a horizontal string.

The internal diameter of each sphere will be 12 ft.—just sufficient for comfortable living, research laboratories or for storing underwater exploration equipment. New materials are being devised to stand up to pressure of over 5,000 lb. per square inch, which the spheres will be subjected to.

A small atomic reactor will produce electricity for the scientists working beneath the waves. By studying marine life and experimenting with samples, they will, eventually, be able to exploit the sea's minerals. In innumerable other ways they will probe the secrets of the ocean.

Oceanography—the science of the sea—is entering a new and exciting phase.



## KEY TO NUMBERED PARTS

(1) Anchorage for the first sphere, driven deep into the sea bed. (2) Observation windows. (3) Cine-camera. (4) 1,000-watt floodlight. (5) Camera recorder. (6) Access to sphere above. (7) Watertight connections for future spheres. (8) Higher level sphere joined to the anchorage sphere. (9) Observation windows. (10) Camera recording equipment. (11) Connecting hatch. (12) Pressure hull. (13) Entrance hatch. (14) Each sphere is joined by a watertight connection. (15) Scientists' accommodation. (16) Connecting hatch. (17) Electric galley and eating accommodation. (18) Connecting hatch.

(19) Research laboratory. (20) Oxygen cylinders. (21) Pressure hull and atomic radiation shielding. (22) Control rods. (23) Atomic pile reactor. (24) Heat exchanger. Here steam is produced for driving the turbines, which in turn drive the electricity generator. (25) Steam turbines. (26) Electricity generator supplying all the 'village' services. (27) Other spheres containing more living quarters and laboratories. (28) End sphere and watertight connections. (29) Additional sphere about to be connected. (30) Special submarine which brings the spheres down from the surface.

ASHWELL  
WOOD

AN EAGLE  
cutaway  
DRAWING



# ESCAPE FROM THE DEEP

IN recent years much attention has been given to the methods of escape from sunken or damaged submarines, but owing to the great pressures of sea water at depth, many problems are involved.

After the loss of the U.S. atomic submarine *Thresher* in 1963, with 130 men inside, a big boost was given to research of the underwater world.

At 8,000 ft., the *Thresher* was beyond reach of man and his technology. Now, however, there is under development for the U.S. Navy's Deep Submergence programme a special submarine to rescue men from a sunken or damaged submarine.

After the sunken submarine has been found and marked, the rescue submarine goes down and automatically locks itself on to the fore or aft escape hatch of the damaged submarine. The crew are transferred, one at a time, into the pressure chambers of the rescue submarine. All hatches are then closed and the rescue craft proceeds to the surface.

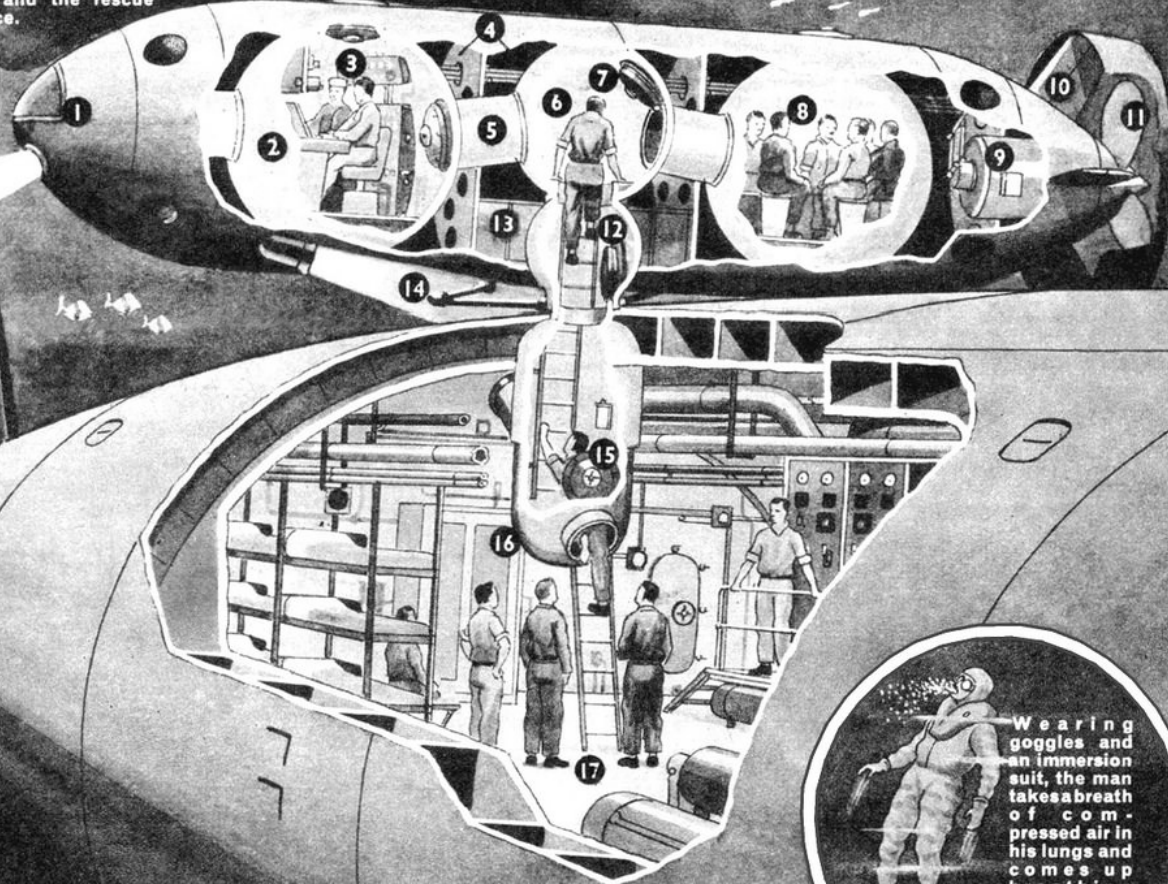
## KEY TO RESCUE SUBMARINE

(1) Observation window. (2) Control room pressure chamber. (3) Captain and navigator controlling all movements. (4) Free flooding area. (5) Connections between pressure chambers. (6) Intermediate pressure chamber. (7) Intermediate hatches - both sides. (8) Rescued crew pressure chamber. (9) Electric propulsion motor. (10) Steering and diving rudders. (11) Reversible pitch propeller. (12) Submarine hatch open. (13) Watertight batteries. (14) Locking-on gear and watertight point.

## KEY TO DAMAGED SUBMARINE

(15) Lower hatch, open. (16) One-man escape chamber. (17) Aft watertight compartment and crew space of an atomic submarine.

The rescue submarines, each with 12 rescued men, proceed to the surface and the awaiting rescue ships. They then return to the damaged submarine for more men.



Wearing goggles and an immersion suit, the man takes a breath of compressed air in his lungs and comes up breathing out. Rate of ascent is 4 ft. per second.

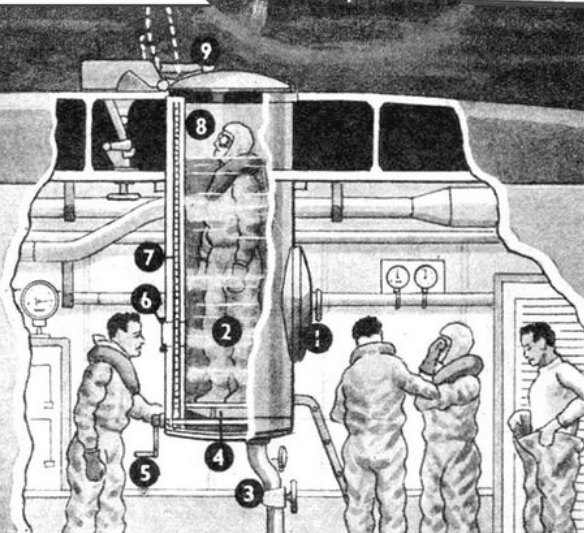
AN EAGLE  
cutaway  
DRAWING

## THE FREE ASCENT METHOD

The existing British method of escape. One man at a time enters a chamber which is then flooded. Each man opens a hatch, which automatically closes behind him, and he comes to the surface while the chamber is drained ready for the next escapee.

## Key to numbered parts

(1) Entrance hatch. (2) One-man escape chamber being flooded. (3) Drain pipe. (4) Should a man faint, the floor can be raised to clear the chamber. (5) Handle for raising and lowering floor. (6) Observation window. (7) Floor chain gear. (8) Air under pressure. (9) Automatic hatch control.

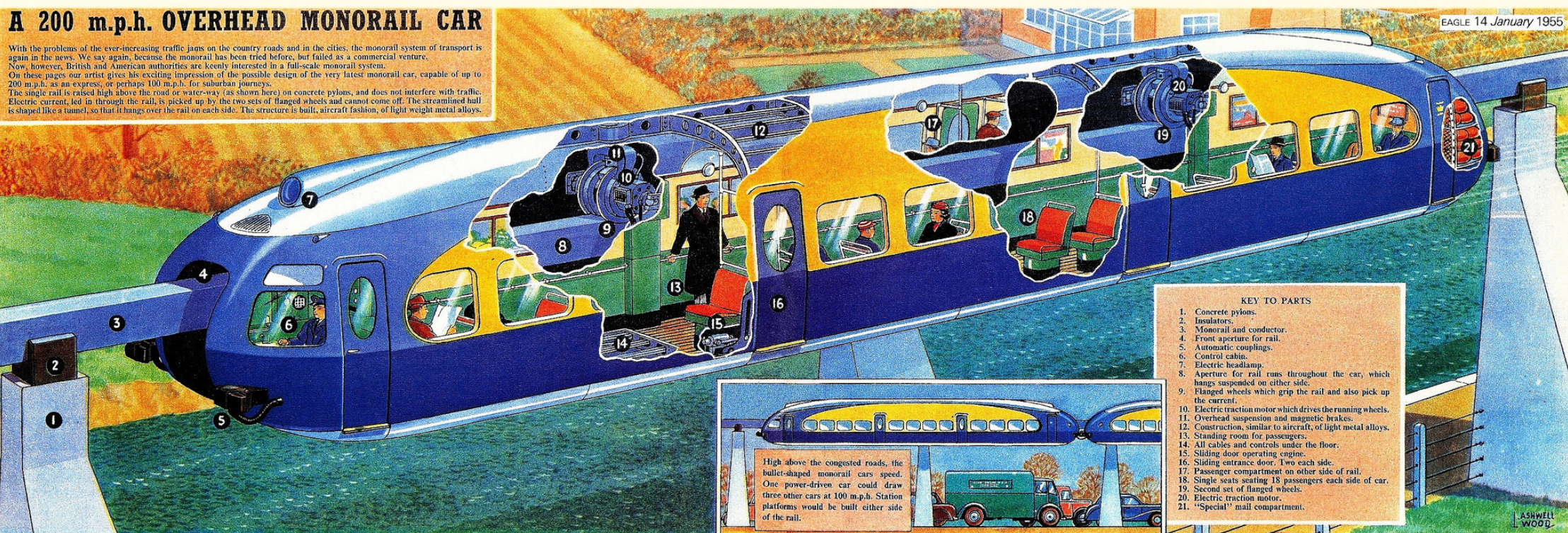




# A 200 m.p.h. OVERHEAD MONORAIL CAR

EAGLE 14 January 1955

With the problems of the ever-increasing traffic jams on the country roads and in the cities, the monorail system of transport is again in the news. We say again, because the monorail has been tried before, but failed as a commercial venture. Now, however, British and American authorities are keenly interested in a full-scale monorail system. On these pages our artist gives his exciting impression of the possible design of the very latest monorail car, capable of up to 200 m.p.h. as an express, or perhaps 100 m.p.h. for suburban journeys. The single rail is raised high above the road or water-way (as shown here) on concrete pylons, and does not interfere with traffic. Electric current, led in through the rail, is picked up by the two sets of flanged wheels and cannot come off. The streamlined hull is shaped like a tunnel, so that it hangs over the rail on each side. The structure is built, aircraft fashion, of light weight metal alloys.



## KEY TO PARTS

1. Concrete pylons.
2. Insulators.
3. Monorail and conductor.
4. Front aperture for rail.
5. Automatic couplings.
6. Control cabin.
7. Electric headlamp.
8. Aperture for rail runs throughout the car, which hangs suspended on either side.
9. Flanged wheels which grip the rail and also pick up the current.
10. Electric traction motor which drives the running wheels.
11. Overhead suspension and magnetic brakes.
12. Construction, similar to aircraft, of light metal alloys.
13. Standing room for passengers.
14. All cables and controls under the floor.
15. Sliding door operating engine.
16. Sliding entrance door. Two each side.
17. Passenger compartment on other side of rail.
18. Single seats seating 18 passengers each side of car.
19. Second set of flanged wheels.
20. Electric traction motor.
21. "Special" mail compartment.

High above the congested roads, the bullet-shaped monorail cars speed. One power-driven car could draw three other cars at 100 m.p.h. Station platforms would be built either side of the rail.



# New Style Sea Transport

An entirely new concept of cargo carrying for ships is being developed at many major ports in the British Isles. This is the container revolution: door-to-door service. Steel containers, 20, 30 and 40 feet long are speedily loaded into special container ships, ready to be transported all over the world. Apart from the speed of loading and unloading, the advantage of the container system is that goods can be packed and sealed at a factory, then transferred by road or rail directly to a ship, still sealed—so there is no pilfering, and no possibility of goods going astray.

At the special docks giant transporter cranes called "Portainers," built by Vickers Engineering Group of Newcastle-upon-Tyne, hoist the 20 ton containers and load them into the holds of the specially built Container ships. Loading or unloading a container takes less than 1½ minutes.

The 4,500 ton container ship shown here has a capacity for 148 containers, each 30 feet long. 110 of them are loaded into 8 compartments and 38 stowed on the 8 hatch covers. Container ports already in operation are at Felixstowe, Tilbury, Southampton, Newport, and Waterford.



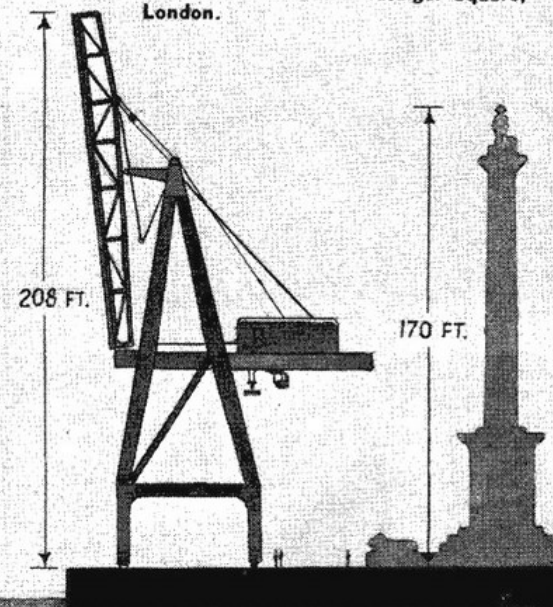
## KEY TO TRANSPORTER CRANE

1. Four leg electric drive of gantry for travel along dockside. 2. Operations cab. This travels backwards and forwards together with the container lifting trolley. 3. Container lifting beam. 4. Lifting trolley drive cables. 5. Main boom. 6. Boom hoist cables. The boom can be raised to the vertical position when a ship is docking. 7. Boom support cables. 8. Gantry beams. 9. Container lifting cable machinery. 10. Trolley and operator's cab cable drive machinery. 11. Aircraft warning light. 12. Boom back-stays. 13. Boom hoist machinery. 14. Limit of travel of cab and container lift. 15. Operator's stairway. 16. Gantry travel rails.

## KEY TO 4,500 TON CONTAINER SHIP

17. Rudder. 18. Starboard propeller. 19. Main twin diesel engines. 20. Diesel generator. 21. Oil fuel tanks. 22. Crew's accommodation. 23. Officer's cabins. 24. Navigating bridge. 25. No. 7 hatch cover stowed on No. 8 hatch. 26. Container guides and cellular bulkheads in Nos. 6 and 7 compartments. 27. Double bottom and side hull construction. 28. Containers in Nos. 4 and 5 compartments. 29. No. 6 hatch cover stowed on No. 5 hatch. 30. Containers fixed to Nos. 1, 2, 3, 4 hatch covers.

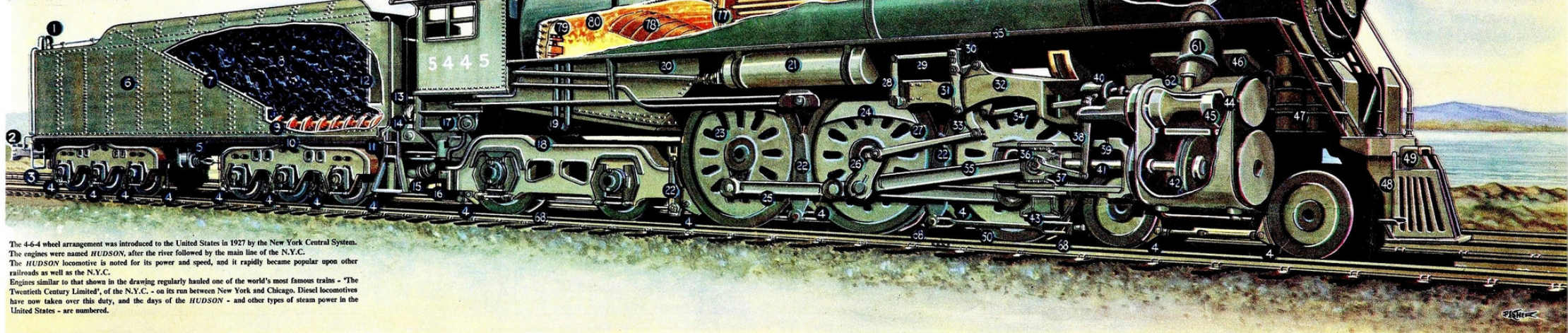
The "Portainer" transporter crane with boom raised. This engineering giant is compared in height with Nelson's Column in Trafalgar Square, London.





# AN AMERICAN 4-6-4 HUDSON STEAM LOCOMOTIVE

KEY TO NUMBERED PARTS: (1) End ladder. (2) Tender coupler. (3) Tender rear step. (4) Brake shoe. (5) Tender brake cylinder. (6) Water tank; capacity, 12,500 gallons. (7) Tender slope sheet. This 'gravity feeds' coal on to conveyor-screw. (8) Fuel space; capacity, 24 tons. (9) Conveyor-screw to Stoker. (10) The tender is borne on two six-wheel bogie-trucks. (11) Tender gangway step. (12) Coal gate. (13) Cab apron. (14) Stoker intermediate conveyor. (15) Tank water hose. (16) Booster engine, providing auxiliary power by driving rear wheels of trailing bogie. (17) Equalizing reservoir. (18) Trailing bogie-truck frame. (19) Suction pipe and injector overflow pipe. (20) Power reverse operating shaft. (21) Main air reservoir. (22) Brake hanger. (23) Scullin 79-inch diameter driving wheels. (24) Counterbalance. (25) Coupling rods. (26) Eccentric crank. (27) Eccentric rod. (28) Reverse shaft arm. (29) Valve gear reach rod. (30) Bell crank. (31) Radius bar. (32) Valve gear frame. (33) Valve gear arm. (34) Valve rod. (35) Main connecting rod. (36) Crosshead. (37) Union link. (38) Combination lever. (39) Crosshead guide. (40) Driving wheel brake cylinder. (41) Piston rod. (42) Piston. (43) Crosshead step. (44) Valve chamber. (45) Piston valve. (46) Cylinder saddle. (47) Air-compressor pumps. (48) Commonwealth drop-coupler pilot. (49) Drop-coupler housing. (50) Brake pull rod. (51) Smoke-box. (52) Smokebox door. (53) Headlight and support. (54) Feedwater heater. This uses the latent heat of the exhaust to heat up the water, which is then forced into the boiler by a pump. (55) Booster Exhaust stack. (56) Smokestack. (57) Smokestack extension. (58) Bell; rung by air pressure. (59) Superheater header. (60) Superheater tubes. (61) Steam pipe to cylinders. (62) Steam chest relief valve. (63) Front tubesheet. (64) Dry pipe; conducts steam to valve and cylinders. (65) Running-board. (66) Boiler check valve. (67) Sand dome. (68) Sand pipe outlet. (69) Dotted line indicates water-level in boiler and over firebox. (70) Steam dryer. (71) Turret supply steam dryer. (72) Turret dry pipe. (73) Fire tubes. (74) Safety valve. (75) Whistle. (76) Firebox stays. (77) Back tubesheet. (78) Brick arch. (79) Stoker ejector mouthpiece. (80) Firebox. (81) Turret. (82) Cab ventilator. (83) Cab smoke-deflector.



The 4-6-4 wheel arrangement was introduced to the United States in 1927 by the New York Central System. The engines were named HUDSON, after the river followed by the main line of the N.Y.C. The HUDSON locomotive is noted for its power and speed, and it rapidly became popular upon other railroads as well as the N.Y.C. Engines similar to that shown in the drawing regularly hauled one of the world's most famous trains - 'The Twentieth Century Limited', of the N.Y.C. - on its run between New York and Chicago. Diesel locomotives have now taken over this duty, and the days of the HUDSON - and other types of steam power in the United States - are numbered.



# H.M.S. EAGLE

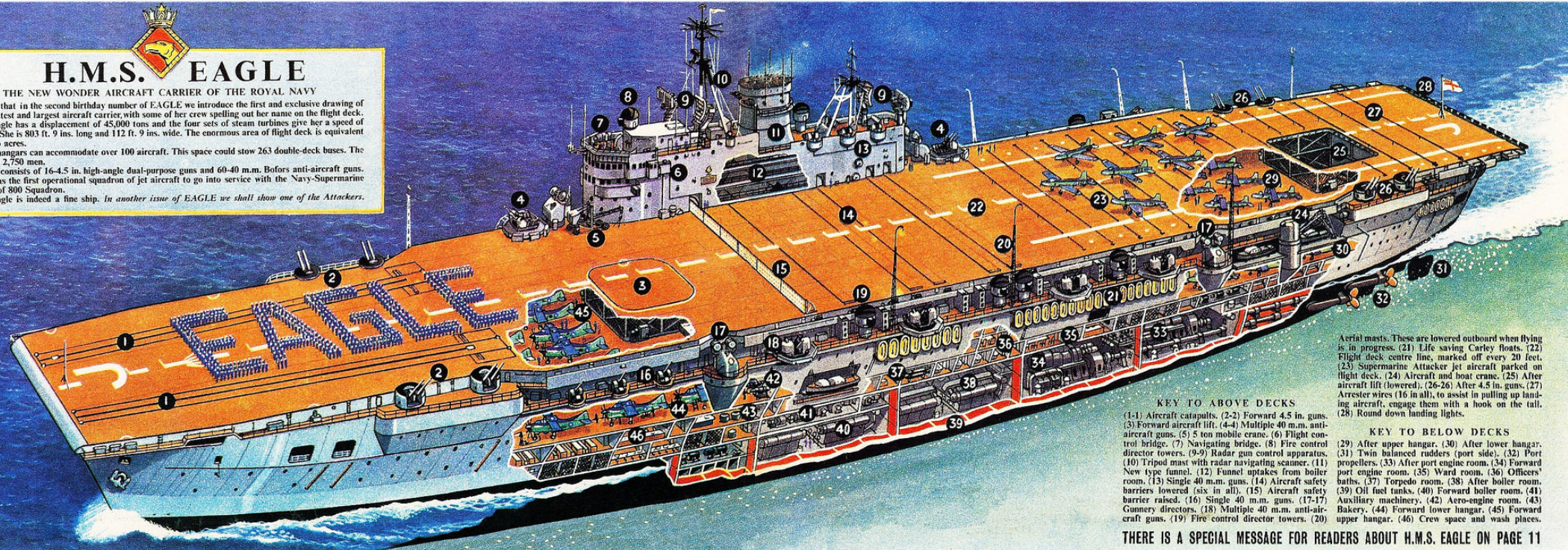
THE NEW WONDER AIRCRAFT CARRIER OF THE ROYAL NAVY

It is fitting that in the second birthday number of EAGLE we introduce the first and exclusive drawing of Britain's latest and largest aircraft carrier, with some of her crew spelling out her name on the flight deck. H.M.S. Eagle has a displacement of 45,000 tons and the four sets of steam turbines give her a speed of 31½ knots. She is 803 ft. 9 ins. long and 112 ft. 9 ins. wide. The enormous area of flight deck is equivalent to over two acres.

The great hangars can accommodate over 100 aircraft. This space could stow 263 double-deck buses. The full crew is 2,750 men.

Armament consists of 16-4.5 in. high-angle dual-purpose guns and 60-40 m.m. Bofors anti-aircraft guns. The ship has the first operational squadron of jet aircraft to go into service with the Navy-Supermarine Attackers of 800 Squadron.

H.M.S. Eagle is indeed a fine ship. In another issue of EAGLE we shall show one of the Attackers.



Aerial masts. These are lowered outboard when flying is in progress. (21) Life saving Carley floats. (22) Flight deck centre line, marked off every 20 feet. (23) Supermarine Attacker jet aircraft parked on flight deck. (24) Aircraft and hoist crane. (25) After aircraft lift (lowered). (26-26) After 4.5 in. guns. (27) Arrestor wires (16 in all), to assist in pulling up landing aircraft, engage them with a hook on the tail. (28) Round down landing lights.

## KEY TO ABOVE DECKS

(1-1) Aircraft catapults. (2-2) Forward 4.5 in. guns. (3) Forward aircraft lift. (4-4) Multiple 40 m.m. anti-aircraft guns. (5) 5 ton mobile crane. (6) Flight control bridge. (7) Navigating bridge. (8) Fire control director towers. (9-9) Radar gun control apparatus. (10) Tripod mast with radar navigating scanner. (11) New type funnel. (12) Funnel uptakes from boiler room. (13) Single 40 m.m. guns. (14) Aircraft safety barriers lowered (six in all). (15) Aircraft safety barrier raised. (16) Single 40 m.m. guns. (17-17) Gunner directors. (18) Multiple 40 m.m. anti-aircraft guns. (19) Fire control director towers. (20)

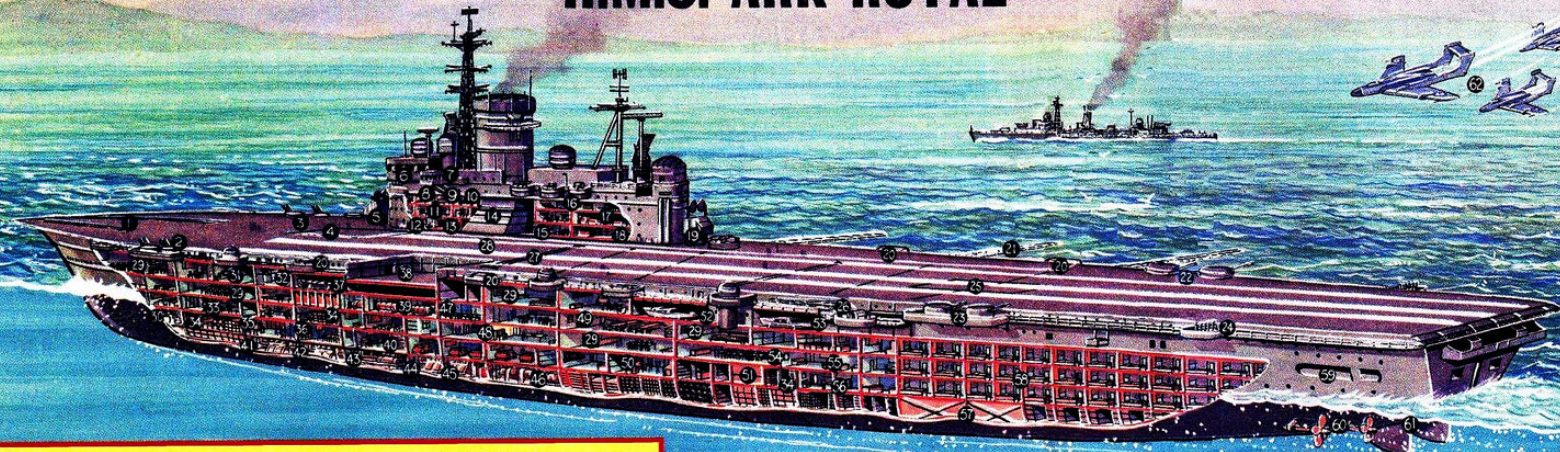
## KEY TO BELOW DECKS

(29) After upper hangar. (30) After lower hangar. (31) Twin balanced rudders (port side). (32) Port propellers. (33) After port engine room. (34) Forward port engine room. (35) Ward room. (36) Officers' baths. (37) Torpedo room. (38) After boiler room. (39) Oil fuel tanks. (40) Forward boiler room. (41) Auxiliary machinery. (42) Aero-engine room. (43) Bakery. (44) Forward lower hangar. (45) Forward upper hangar. (46) Crew space and wash places.

THERE IS A SPECIAL MESSAGE FOR READERS ABOUT H.M.S. EAGLE ON PAGE 11



# H.M.S. ARK ROYAL



Britain's latest aircraft-carrier, H.M.S. *Ark Royal*, is the fourth ship in the Royal Navy to bear the name. The first, of 800 tons, built by Sir Walter Raleigh, was launched in 1587 and was the flagship that sailed out to challenge the Spanish Armada. The new 36,800 ton *Ark Royal* is equipped to weather a nearby atomic explosion, and also to launch an atomic attack herself. She can carry 100 aircraft and a crew of 2,200 officers and men.

## KEY TO NUMBERS

(1) Steam catapults. (2)-(3) 4.5 inch dual-purpose guns. (4) Aircraft lift. (5) Director tower. (6) Bridge. (7) Flying Commander's cabin. (8) Captain's sea-cabin. (9) Navigation officers' sea-cabin. (10) Control room. (11) Executive officers' sea-cabins. (12) Planning rooms. (13) Switch room. (14) Boiler uptakes. (15) Briefing room. (16) Operations rooms. (17) Fan machinery. (18) Ready room. (19) Fire-control tower. (20) Bofors guns.

(21) Radio masts, lowered. (22)-(23) 4.5 inch dual-purpose guns. (24) Deck-landing controller. (25) After aircraft lift. (26) Crane. (27) Arrestor-net, lowered. (28) Angled flight-deck. (29) Mess. (30) Laundry. (31) Air workshops. (32) Showers. (33) Hospital. (34) Stores. (35) Forward remote-control room. (36) Mechanics' mess. (37) 32-foot cutter. (38) Deck-edge lift. (39) Lift machinery. (40) Engineers' offices. (41)-(42) Forward boiler-rooms. (43) Forward port engine-room. (44)-(45) After port boiler-rooms. (46) After port engine-room. (47) Wash-place. (48) Recreation rooms. (49) Dining hall. (50) After remote-control room. (51) Prison. (52)-(53) 36-foot speedboats. (54) Dining hall. (55) Ante-room. (56) Captain's lower office. (57) Fresh-water tanks. (58) Officers' cabins. (59) Quarter deck. (60) Port twin propellers. (61) Twin rudders. (62) D.H.110 two-seat, all-weather, strike aircraft of the type which are scheduled to operate from the *Ark Royal* in the near future.

## ONE OF ARK ROYAL'S REMOTE-CONTROL ROOMS

These rooms are hermetically sealed and air-conditioned, to enable the crew to control the engines and boilers while the ship speeds out of a contaminated area during an atomic attack. Meanwhile, spray nozzles wash the exposed deck.

## KEY TO NUMBERS

(63) Auxiliary air bottles. (64) Steam-pressure gauges. (65) Batteries. (66) Starters for pump motors. (67) Pump motors. (68) Engine-room controls. (69) Boiler-room controls. (70) Engineer-officer in command.



## THE 'ARK ROYAL' OF WORLD WAR II

The predecessor of the latest *Ark Royal* had a short but active career. During World War II, her exploits became almost legendary. On many occasions, she was the target of enemy bombers, and the great ship is seen here in the midst of such an attack, made by squadrons of Italian aircraft.

During this, she at one time disappeared behind a wall of water, flung up by thirty bombs falling around her, some as near as twenty yards away! Eye-witnesses of the action thought she had gone, but she emerged with all her guns blazing 'like a great angry bee'. Again and again, the enemy claimed to have sunk her at different periods during the war, only for her to appear in yet another action, and so prove the falsehood of their propaganda! Very soon after the outbreak of war, she was attacked by three Flying Boats and five Heinkel bombers, as she returned to her base in Scotland. A Heinkel scored a 'near miss' with a 1,000 lb. bomb, but a smoke-screen that had been put up prevented the pilot from seeing exactly what had happened. However, evidently the enemy thought they had sunk her; their radio put out this fact, and the Lance-Corporal pilot of the Heinkel received the Iron Cross and was promoted to Lieutenant in recognition of his 'achievement'. This was the first of many such claims. Despite the numerous attempts to destroy her from the air, she met her end, strange to say, by the action of a German submarine. She was torpedoed about 3.30 on the afternoon of 13th November, 1941, some thirty miles east of Gibraltar. Her Captain thought she might be got to the great naval base, and tugs steamed to her aid. She remained afloat for over twelve hours then, on the following day, despite all efforts to tow her to safety, she heeled over and sank 'like a tired child'. Her aeroplanes went down with her, and all hands, with one exception, were saved - no less than 1,600 officers and men. Today, her gallant spirit lives on, and her famous name again rides the ocean in Britain's latest and greatest aircraft-carrier - H.M.S. *Ark Royal*!



# THE HYDROFOIL FERRY CRAFT

WHEN a ship is travelling through the water, a great deal of power is used in overcoming the friction produced by the hull. However, this problem has been solved by lifting the hull clear of the water.

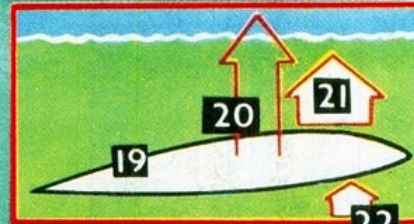
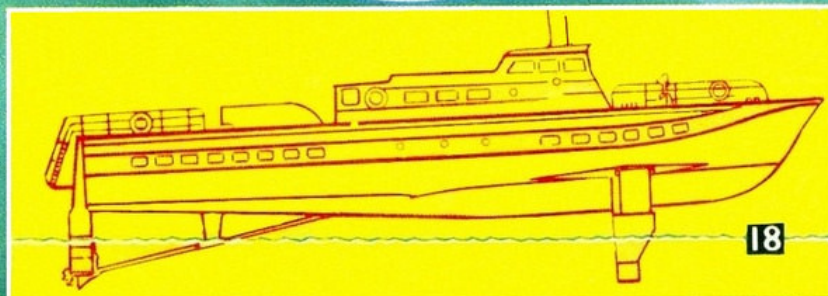
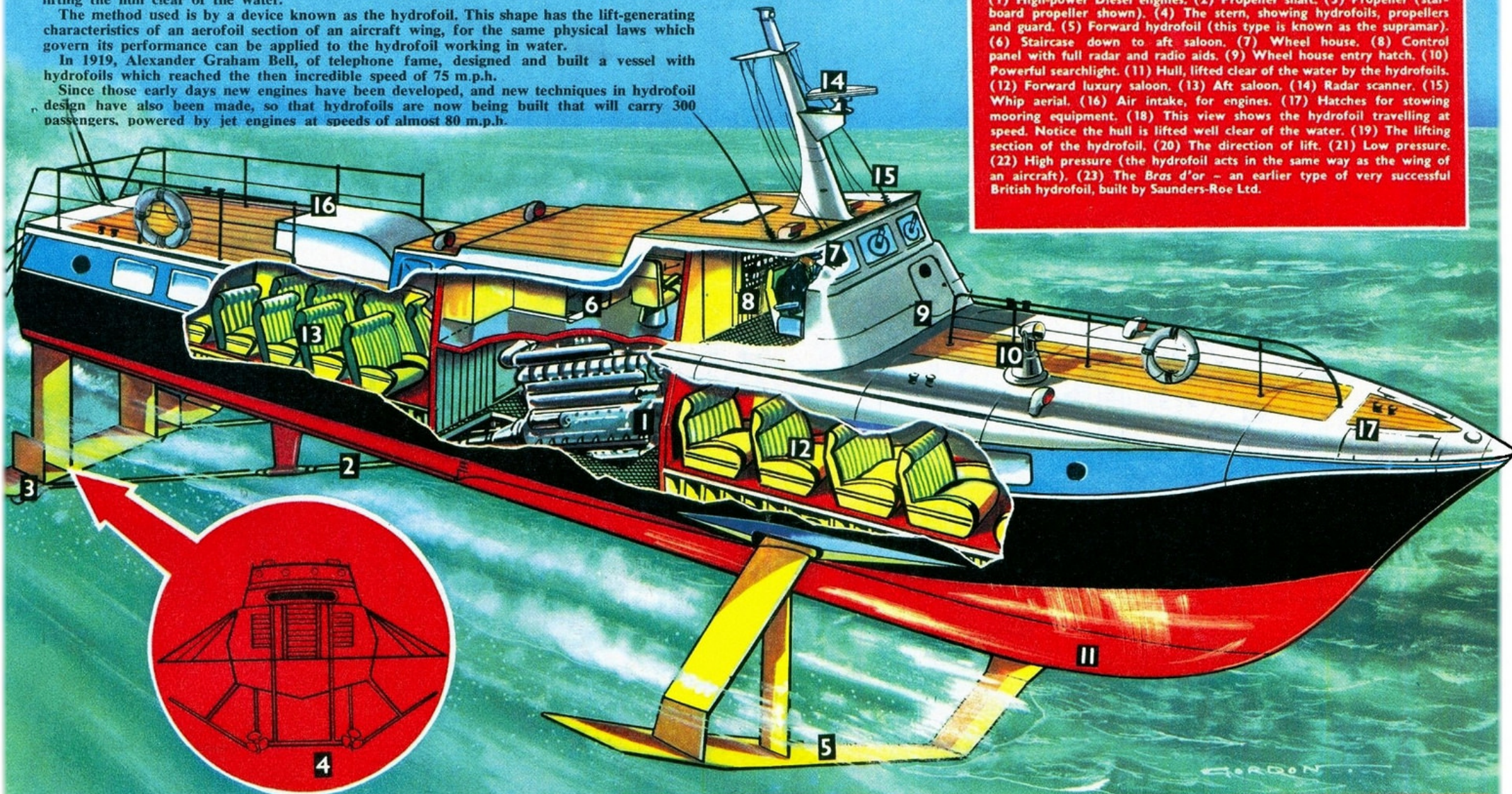
The method used is by a device known as the hydrofoil. This shape has the lift-generating characteristics of an aerofoil section of an aircraft wing, for the same physical laws which govern its performance can be applied to the hydrofoil working in water.

In 1919, Alexander Graham Bell, of telephone fame, designed and built a vessel with hydrofoils which reached the then incredible speed of 75 m.p.h.

Since those early days new engines have been developed, and new techniques in hydrofoil design have also been made, so that hydrofoils are now being built that will carry 300 passengers, powered by jet engines at speeds of almost 80 m.p.h.

## KEY TO HYDROFOIL FERRY CRAFT

(1) High-power Diesel engines. (2) Propeller shaft. (3) Propeller (starboard propeller shown). (4) The stern, showing hydrofoils, propellers and guard. (5) Forward hydrofoil (this type is known as the supramar). (6) Staircase down to aft saloon. (7) Wheel house. (8) Control panel with full radar and radio aids. (9) Wheel house entry hatch. (10) Powerful searchlight. (11) Hull, lifted clear of the water by the hydrofoils. (12) Forward luxury saloon. (13) Aft saloon. (14) Radar scanner. (15) Whip aerial. (16) Air intake, for engines. (17) Hatches for stowing mooring equipment. (18) This view shows the hydrofoil travelling at speed. Notice the hull is lifted well clear of the water. (19) The lifting section of the hydrofoil. (20) The direction of lift. (21) Low pressure. (22) High pressure (the hydrofoil acts in the same way as the wing of an aircraft). (23) The Bras d'or - an earlier type of very successful British hydrofoil, built by Saunders-Roe Ltd.



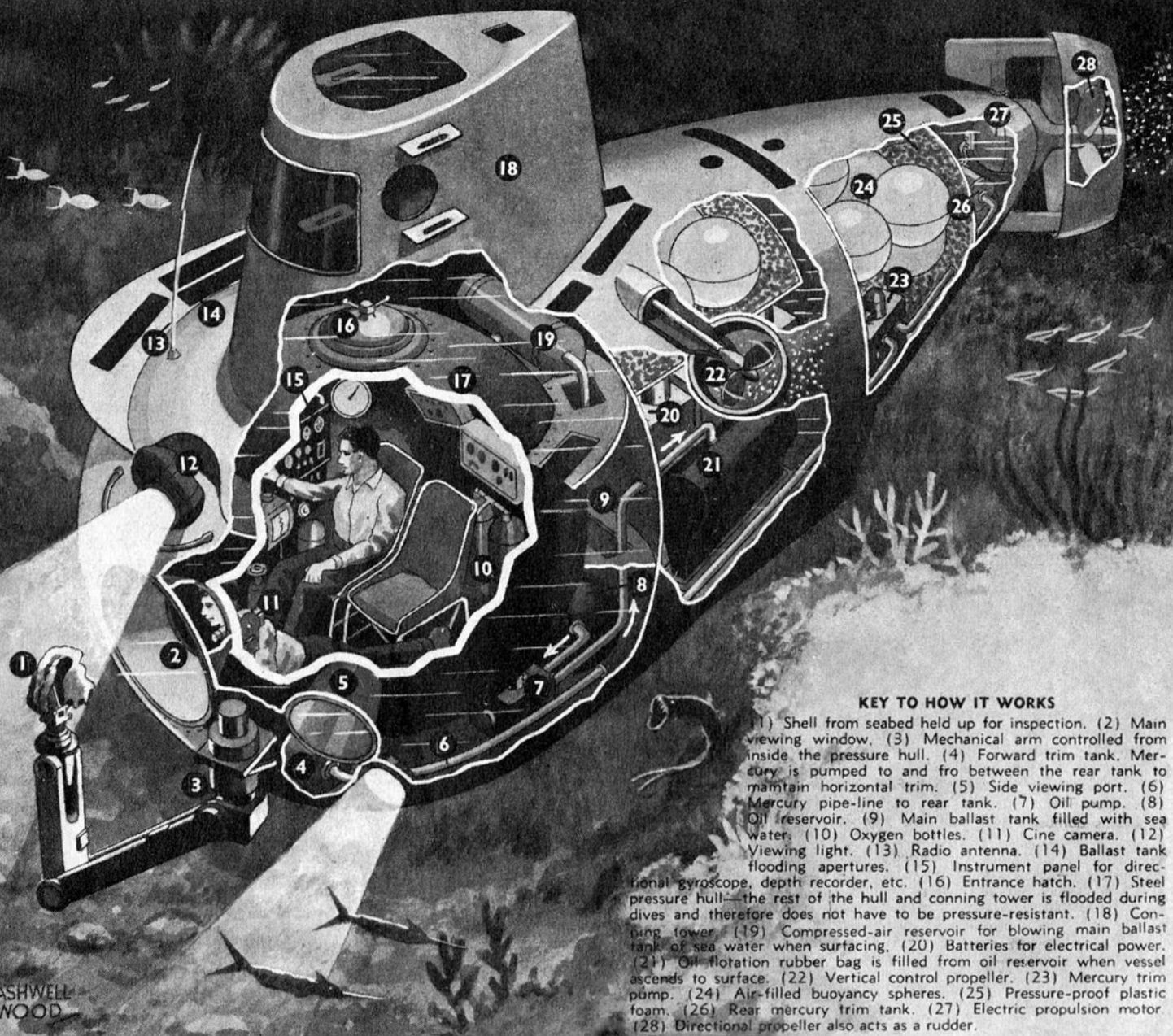
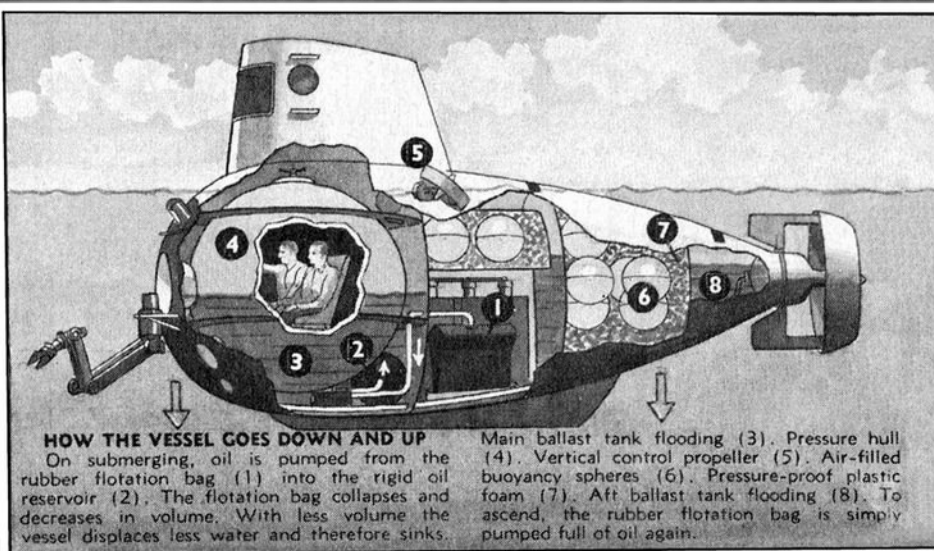


# EXPLORING THE SEA BED

In a previous EAGLE cutaway drawing we showed man's efforts in space by launching a satellite in orbit 300 miles above the earth's surface. On this page we show one of man's efforts in searching 6,000 feet down below the surface of the sea.

Knowledge of the oceans, called Oceanography, will become essential to our survival in the future. The surface of the moon is more familiar to man than the land beneath the sea—a silent, sunless 'inner space' three times greater in area than all the continents combined.

The research vessel Alvin, seen here, operates at 6,000 ft. (or 1,000 fathoms), where water pressure is 2,780 pounds per square inch. The vessel gets neutral buoyancy or hover-ability from air-filled spheres, like large footballs, and pressure-proof plastic foam. Vertical movements, going down to the sea bed and up, are controlled by an ingenious flotation system using the transfer of oil from one compartment to another.



## KEY TO HOW IT WORKS

- (1) Shell from seabed held up for inspection. (2) Main viewing window. (3) Mechanical arm controlled from inside the pressure hull. (4) Forward trim tank. Mercury is pumped to and fro between the rear tank to maintain horizontal trim. (5) Side viewing port. (6) Mercury pipe-line to rear tank. (7) Oil pump. (8) Oil reservoir. (9) Main ballast tank filled with sea water. (10) Oxygen bottles. (11) Cine camera. (12) Viewing light. (13) Radio antenna. (14) Ballast tank flooding apertures. (15) Instrument panel for directional gyroscope, depth recorder, etc. (16) Entrance hatch. (17) Steel pressure hull—the rest of the hull and conning tower is flooded during dives and therefore does not have to be pressure-resistant. (18) Conning tower. (19) Compressed-air reservoir for blowing main ballast tank of sea water when surfacing. (20) Batteries for electrical power. (21) Oil flotation rubber bag is filled from oil reservoir when vessel ascends to surface. (22) Vertical control propeller. (23) Mercury trim pump. (24) Air-filled buoyancy spheres. (25) Pressure-proof plastic foam. (26) Rear mercury trim tank. (27) Electric propulsion motor. (28) Directional propeller also acts as a rudder.



# FLIP SHIP

Overall length—350 feet; draught when vertical—300 feet; crew—6 operators, 6 scientists; weights—600 tons dry, 1,500 tons in towing trim, 2,100 tons when vertical.

America's startling answer to the problem of studying the world's oceans

## FLIPPING SEQUENCE

By gradual flooding of the multi-sectioned hull, the stern sinks until the ship is standing vertically with its hydrophones 300 feet down in the sea. When ready to be towed to another station, compressors in the engine room force air in, and water out, of the tanks, causing the stern to float to the surface.

### KEY TO NUMBERED PARTS

(1) Laboratories. (2) Electronics Laboratories. (3) Crew's quarters. (4) Galley. (5) Engines and compressors. (6) Draught measurements for use when in a horizontal position. (7) Davit. (8) Cat Walk. (9) Ladder for entering FLIP when in vertical position. (10) Cables to electronic equipment at bottom of hull. (11) Compressed-air tank. (12) Draught measurements for use when in vertical position. (13) Entrance to engine room. (14) Bollards. (15) Valve control station. (16) Fans for rotating ship when vertical. (17) Starboard navigation light for use in either position. (18) Port navigation light. (19) Entrance to Electronics Laboratory. (20) Entrance to 'Wet' laboratory. (21) Winch for collecting deep water samples. (22) Mast carrying lights which, when seen, notify shipping that FLIP is not able to manoeuvre. (23) Lifebelt. (24) Outriggers. (25) Hydrophones of various types for specialist purposes. (26) Tank Bulkhead. (27) Tank bulkhead which allows, when the ship is horizontal, water to stay in the lower half of the tank. This acts as ballast, keeping the ship in its correct attitude.

With the population of the world increasing at such a rate, it is only natural that new sources of food should be sought. And, as three-fifths of the world's surface is under water and teeming with life, it is natural that man must intrude into its depths. One answer is the brand new 'FLIP' being run by the Scripps Institute of Oceanography, an important part of the University of California.

In this floating laboratory, FLIP's crew of specialists and scientists are probing the depths, studying fish migration and mineral contents, tidal flow of the sea and sound waves, and charting the ocean floor. Before Man can farm and mine under the sea, all these problems will have to be solved.

FLIP is a ship with a difference. She is towed into position and then by flooding the tubular stern, one end sinks and the decks become bulkheads and the bulkheads become decks and ceilings. All engines, compressors, galley equipment, etc., are gimbelled so that they can be used in horizontal or vertical positions.

While drifting, the FLIP (Floating Instrument Platform) can ride almost motionless, even in 30 ft. waves. With food being the key to the survival of life on earth, the research being done by Scripps is not only interesting, but essential!

J. H. Batchelor.



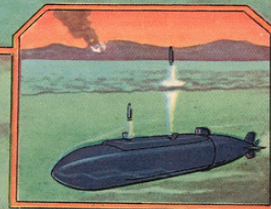
# ATOMIC CARGO SUBMARINE - MOBY DICK

Work on a new British cargo-carrying submarine is now well under way. Aptly named *Moby Dick*, the vessel will be atomic powered, and will be the world's first commercial underwater ship. Bearing in mind the voyage of American atomic submarines under the North Pole, *Moby Dick* is designed to play an important part in opening up trade with the ice-bound regions of Northern Canada. Her first cargo will be 28,000 tons of iron ore, but other bulk cargoes could include fuel oil, etc. This underwater monster, with a displacement of 50,000 tons, will be 607 ft. long and 72 ft. in diameter. Her atomic-powered engines will develop 75,000 h.p., and give a submerged speed of 25 knots. Refuelling would only be required about every eighteen months. The *Moby Dick* project has been developed by Mr F. G. Mitchell, head of an Engineering firm, and the Admiralty has expressed interest in his work.

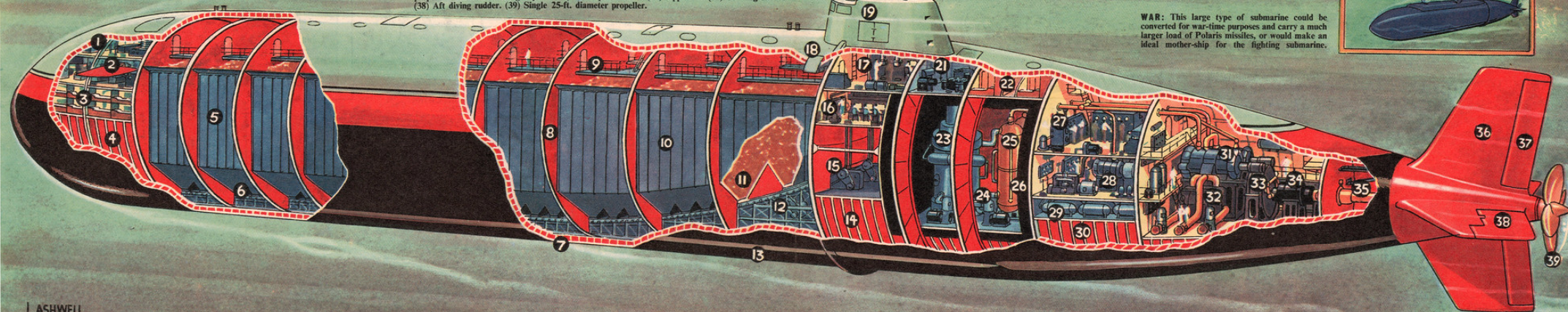
## KEY TO NUMBERED PARTS

(1) Forward control-room. (2) Fore diving rudder, or hydroplane. (3) Crew's quarters, stores, etc. (4) Fore trim sea-water tanks and buoyancy control. (5) Fore cargo-hoppers; total capacity, 28,000 tons of iron ore. (6) Twin conveyor-belts for unloading cargo. (7) Compensating trim tanks and double skin. (8) Watertight bulkheads. (9) Port gangway and watertight doors. (10) Aft cargo-hoppers. (11) Section of a cargo-hopper. (12) Twin conveyor-belts. (13) Anti-rolling bilge keel. (14) Amidships trim tanks. (15) Conveyor-belt machinery in air-pressure space. (16) Radar room. (17) Control and periscope room. (18) Extendable cross-conveyor for unloading. (19) Conning tower. (20) Periscopes. (21) Atomic reactor charging-room. (22) Officers' quarters. (23) Atomic reactor of the boiling heavy-water type. (24) Reactor heavy-water circulating pumps. (25) Heat exchangers, producing steam for turbines. (26) Anti-radiation shielding. (27) Engine control-room. (28) Auxiliary machinery and electricity-generating room. (29) Compressed-air chambers for controlling trim tanks. (30) Aft sea-water trim tanks. (31) Engine room, with high and low pressure steam turbines developing 75,000 h.p. (32) Condenser. (33) Reduction gearing. (34) Electric-propulsion motor for emergency drive. (35) Propeller shaft. (36) Upper fin. (37) Steering rudder. (38) Aft diving rudder. (39) Single 25-ft. diameter propeller.

**PEACE:** The cargo-carrying submarine could proceed at full speed under ice-bound Hudson Bay during the closed season, with the aid of her radar warning beam, and reach normally-closed harbours.



**WAR:** This large type of submarine could be converted for war-time purposes and carry a much larger load of Polaris missiles, or would make an ideal mother-ship for the fighting submarine.





# OIL

# UNDER THE SEA

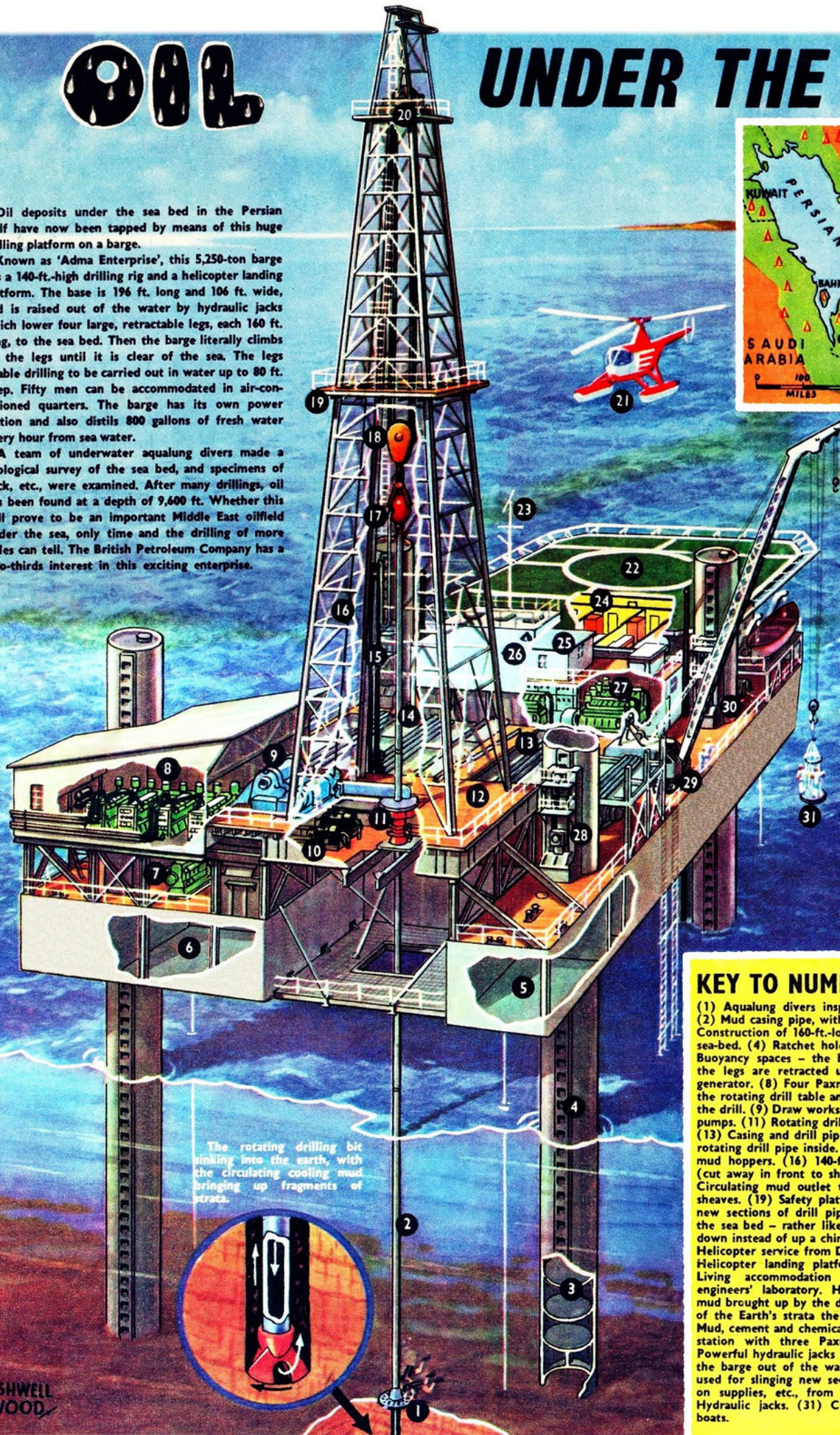
Oil deposits under the sea bed in the Persian Gulf have now been tapped by means of this huge drilling platform on a barge.

Known as 'Adma Enterprise', this 5,250-ton barge has a 140-ft.-high drilling rig and a helicopter landing platform. The base is 196 ft. long and 106 ft. wide, and is raised out of the water by hydraulic jacks which lower four large, retractable legs, each 160 ft. long, to the sea bed. Then the barge literally climbs up the legs until it is clear of the sea. The legs enable drilling to be carried out in water up to 80 ft. deep. Fifty men can be accommodated in air-conditioned quarters. The barge has its own power station and also distils 800 gallons of fresh water every hour from sea water.

A team of underwater aqualung divers made a geological survey of the sea bed, and specimens of rock, etc., were examined. After many drillings, oil has been found at a depth of 9,600 ft. Whether this will prove to be an important Middle East oilfield under the sea, only time and the drilling of more holes can tell. The British Petroleum Company has a two-thirds interest in this exciting enterprise.



The position of the drilling barge in the Persian Gulf and the surrounding oilfields on land.



The rotating drilling bit sinking into the earth, with the circulating cooling mud bringing up fragments of strata.

## KEY TO NUMBERED PARTS

(1) Aqualung divers inspecting drill hole on sea bed. (2) Mud casing pipe, with rotating drill pipe inside. (3) Construction of 160-ft.-long retractable legs resting on sea-bed. (4) Ratchet holes for hydraulic jacks. (5)-(6) Buoyancy spaces - the barge floats on the sea when the legs are retracted upwards. (7) Auxiliary Diesel generator. (8) Four Paxman Diesel engines for driving the rotating drill table and the draw works for hoisting the drill. (9) Draw works gearbox. (10) Mud circulation pumps. (11) Rotating drill table. (12) Drilling platform. (13) Casing and drill pipe racks. (14) Mud casing with rotating drill pipe inside. (15) Mud pipes to pumps and mud hoppers. (16) 140-ft.-high derrick superstructure (cut away in front to show hoist and drill pipe). (17) Circulating mud outlet to pumps. (18) Drill hoisting sheaves. (19) Safety platform from which men can fix new sections of drill pipe as the others descend into the sea bed - rather like a sweep's broom which goes down instead of up a chimney. (20) Crown pulley. (21) Helicopter service from Das Island, 24 miles away. (22) Helicopter landing platform. (23) Radio aerial. (24) Living accommodation on two decks. (25) Oil engineers' laboratory. Here, specimens of rock and mud brought up by the drill tell the oil-men what kind of the Earth's strata the drill is passing through. (26) Mud, cement and chemical storage hoppers. (27) Power station with three Paxman Diesel generators. (28) Powerful hydraulic jacks which lower the legs and raise the barge out of the water. (29) 30-ton mobile crane used for slinging new sections of drill pipe and taking on supplies, etc., from boats from Das Island. (30) Hydraulic jacks. (31) Crane platform for men from boats.



# THE WORLD'S FIRST ATOMIC SUBMARINE

IN EAGLE May 23rd, 1952, we featured an impression of a future atomic submarine. Now, in 1955, this has come to life; the United States' atomic submarine *Nautilus*, shown here, has just completed very successful trials. She uses atomic or nuclear energy as the main source of power, in a manner that closely resembles our previous prediction.

The *Nautilus* is 320 feet long and weighs 3,180 tons when surfaced. She is reputed to have a submerged speed of up to 25 knots and can circle the world several times without refuelling.

LASHWELL  
WOOD

**KEY TO HOW IT WORKS:** (1) Atomic or nuclear reactor containing tubes of 'Uranium 235', the fuel, which generates enormous heat. (2) Circulating pump for the heavy water coolant which draws off the heat. (3) Distilled water return from condensers. This is immediately turned into steam. (4) Heat exchanger. (5) Steam supply to turbines. (6) Shielded control-rod drive. (7) Heavy outer shielding to prevent radiation. (8) High pressure steam turbine. (9) Low pressure steam turbine. (10) Reduction gearing and clutches. (11) Electric propulsion motor, disengaged. When used as a second method of propulsion, this is driven either by the Diesel generator or by batteries. (12) Starboard propeller shaft. Only the starboard engines are shown. (13) Condensers, where exhaust steam is condensed back into distilled water. (14) Distilled water pump to heat exchanger; thus the water and steam go round in a closed circuit. (15) Diesel electric

generator. (16) Engine control station. **KEY TO OTHER PARTS:** (17) Rudders. (18) Stern diving hydroplane. (19) Port propeller. (20) Air conditioning and hydraulic machinery. (21) After crew's quarters. (22) After escape hatch. (23) After access hatch. (24) Diesel exhaust and muffler. (25) "Snort" fresh-air intake and exhaust. (26) Radar and radio aerials. (27) Twin periscopes. (28) Surface navigating bridge. (29) Attack centre and sonar sounding room. (30) Section of outer hull containing water ballast tanks. (31) Main ballast tanks and periscope well. (32) Diving and steering control centre. (33) Periscope room. (34) Watertight doors. (35) Commander's cabin. (36) Forward access hatch. (37) Officers' ward room. (38) Crew's mess and galley. (39) Batteries. (40) Stores. (41) Forward escape hatch. (42) Forward crew's quarters. (43) Spare torpedoes. (44) Six forward torpedo tubes. (45) Bow diving hydroplane.



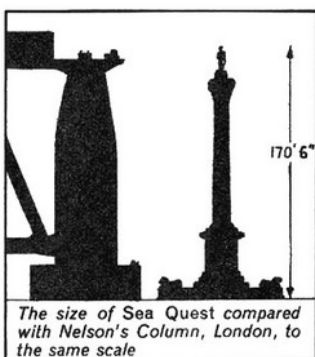
# FISHING FOR FUEL

If all goes well, Britain may receive at least 50 million cubic feet of natural methane gas a day from the North Sea bed. This is equivalent to 500,000 tons of coal a year. The gas is enough to supply a city such as Leeds or Sheffield with all its needs, and what is more, the natural gas has about twice the heating value of coal gas.

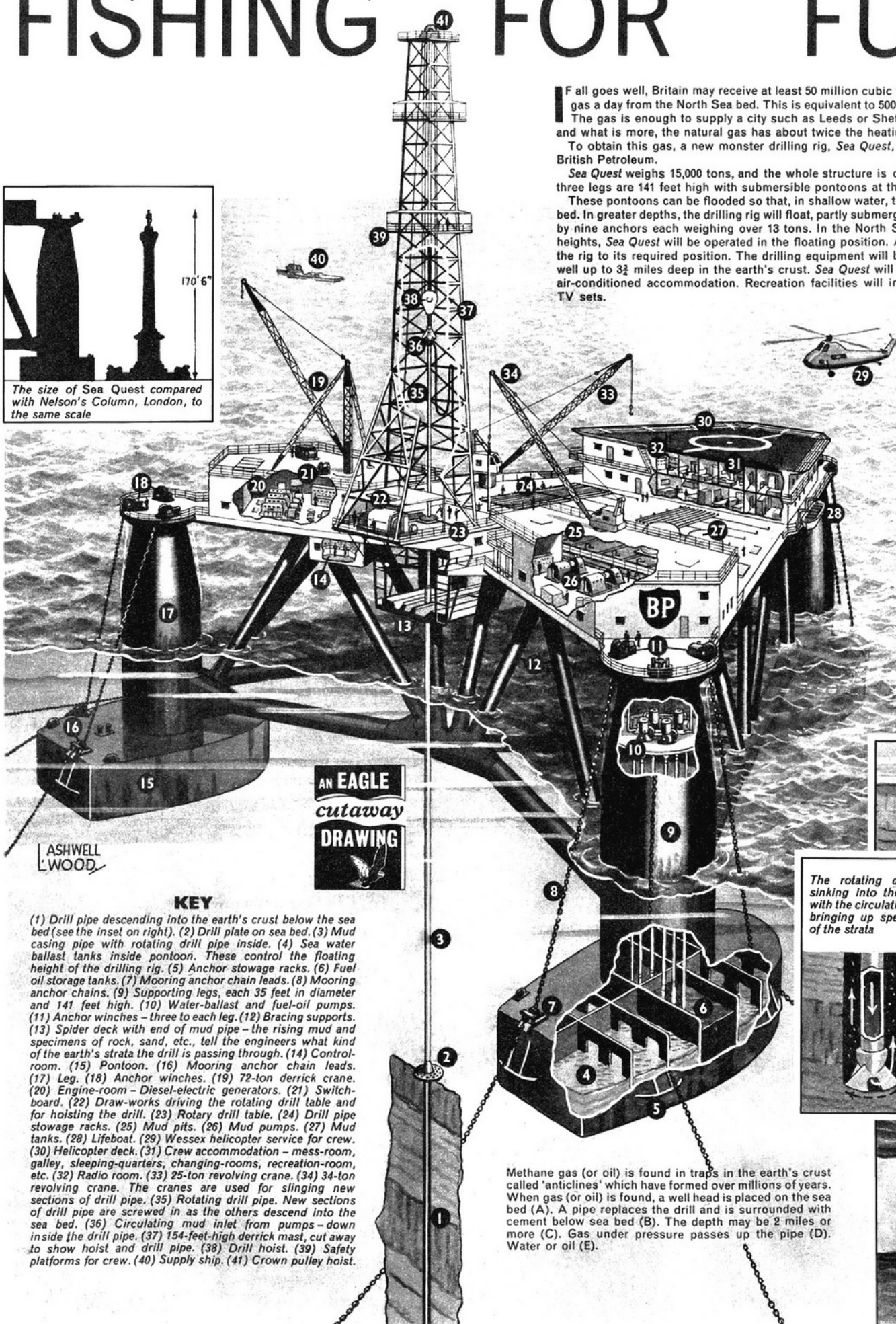
To obtain this gas, a new monster drilling rig, *Sea Quest*, has just been built for British Petroleum.

*Sea Quest* weighs 15,000 tons, and the whole structure is over 350 feet high. The three legs are 141 feet high with submersible pontoons at the base.

These pontoons can be flooded so that, in shallow water, they will rest on the sea bed. In greater depths, the drilling rig will float, partly submerged and held in position by nine anchors each weighing over 13 tons. In the North Sea, owing to the wave heights, *Sea Quest* will be operated in the floating position. A powerful tug will tow the rig to its required position. The drilling equipment will be capable of sinking a well up to 3½ miles deep in the earth's crust. *Sea Quest* will have a crew of 40 with air-conditioned accommodation. Recreation facilities will include film shows and TV sets.



The size of *Sea Quest* compared with Nelson's Column, London, to the same scale

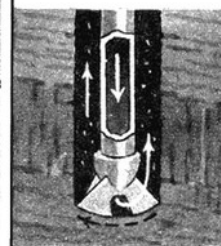


AN EAGLE  
cutaway  
DRAWING

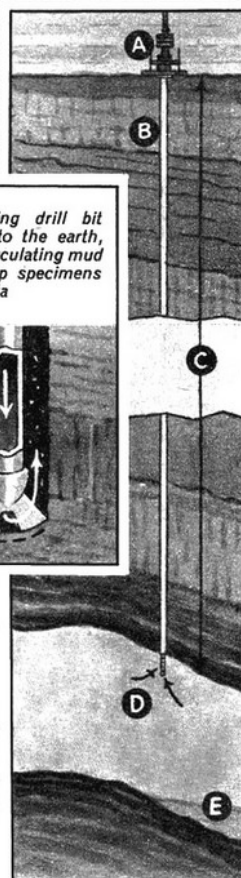
## KEY

(1) Drill pipe descending into the earth's crust below the sea bed (see the inset on right). (2) Drill plate on sea bed. (3) Mud casing pipe with rotating drill pipe inside. (4) Sea water ballast tanks inside pontoon. These control the floating height of the drilling rig. (5) Anchor stowage racks. (6) Fuel oil storage tanks. (7) Mooring anchor chain leads. (8) Mooring anchor chains. (9) Supporting legs, each 35 feet in diameter and 141 feet high. (10) Water-ballast and fuel-oil pumps. (11) Anchor winches - three to each leg. (12) Bracing supports. (13) Spider deck with end of mud pipe - the rising mud and specimens of rock, sand, etc., tell the engineers what kind of the earth's strata the drill is passing through. (14) Control room. (15) Pontoon. (16) Mooring anchor chain leads. (17) Leg. (18) Anchor winches. (19) 72-ton derrick crane. (20) Engine room - Diesel-electric generators. (21) Switch-board. (22) Draw-works driving the rotating drill table and for hoisting the drill. (23) Rotary drill table. (24) Drill pipe stowage racks. (25) Mud pits. (26) Mud pumps. (27) Mud tanks. (28) Lifeboat. (29) Wessex helicopter service for crew. (30) Helicopter deck. (31) Crew accommodation - mess-room, galley, sleeping-quarters, changing-rooms, recreation-room, etc. (32) Radio room. (33) 25-ton revolving crane. (34) 34-ton revolving crane. The cranes are used for slinging new sections of drill pipe. (35) Rotating drill pipe. New sections of drill pipe are screwed in as the others descend into the sea bed. (36) Circulating mud inlet from pumps - down inside the drill pipe. (37) 154-foot-high derrick mast, cut away to show hoist and drill pipe. (38) Drill hoist. (39) Safety platforms for crew. (40) Supply ship. (41) Crown pulley hoist.

The rotating drill bit sinking into the earth, with the circulating mud bringing up specimens of the strata



Methane gas (or oil) is found in traps in the earth's crust called 'anticlines' which have formed over millions of years. When gas (or oil) is found, a well head is placed on the sea bed (A). A pipe replaces the drill and is surrounded with cement below sea bed (B). The depth may be 2 miles or more (C). Gas under pressure passes up the pipe (D). Water or oil (E).





# WORLD'S BIGGEST ROBOT



## KEY TO NUMBERED PARTS

Dwarfed by  
Beetle, a swim-  
sued girl shows  
robot's huge size

**THIS** 85-ton giant, that can pick up an egg with the touch of a child, was in action for the first time recently.

Called the Beetle, the huge vehicle was built for the American Air Force by the General Electric Company. Controlled by an operator in the cab, the Beetle can move in close to a radio-active nuclear reactor or reactor to make adjustments or perform emergency operations.

The operator is protected from harmful radiation by foot-thick lead shielding. The whole cab, to which the arms are attached, rises on four hydraulic stanchions to a height of 25 feet above ground level, and rotates as required.

The Beetle can also 'see' round corners (and inside reactors or power-plants) with a closed-

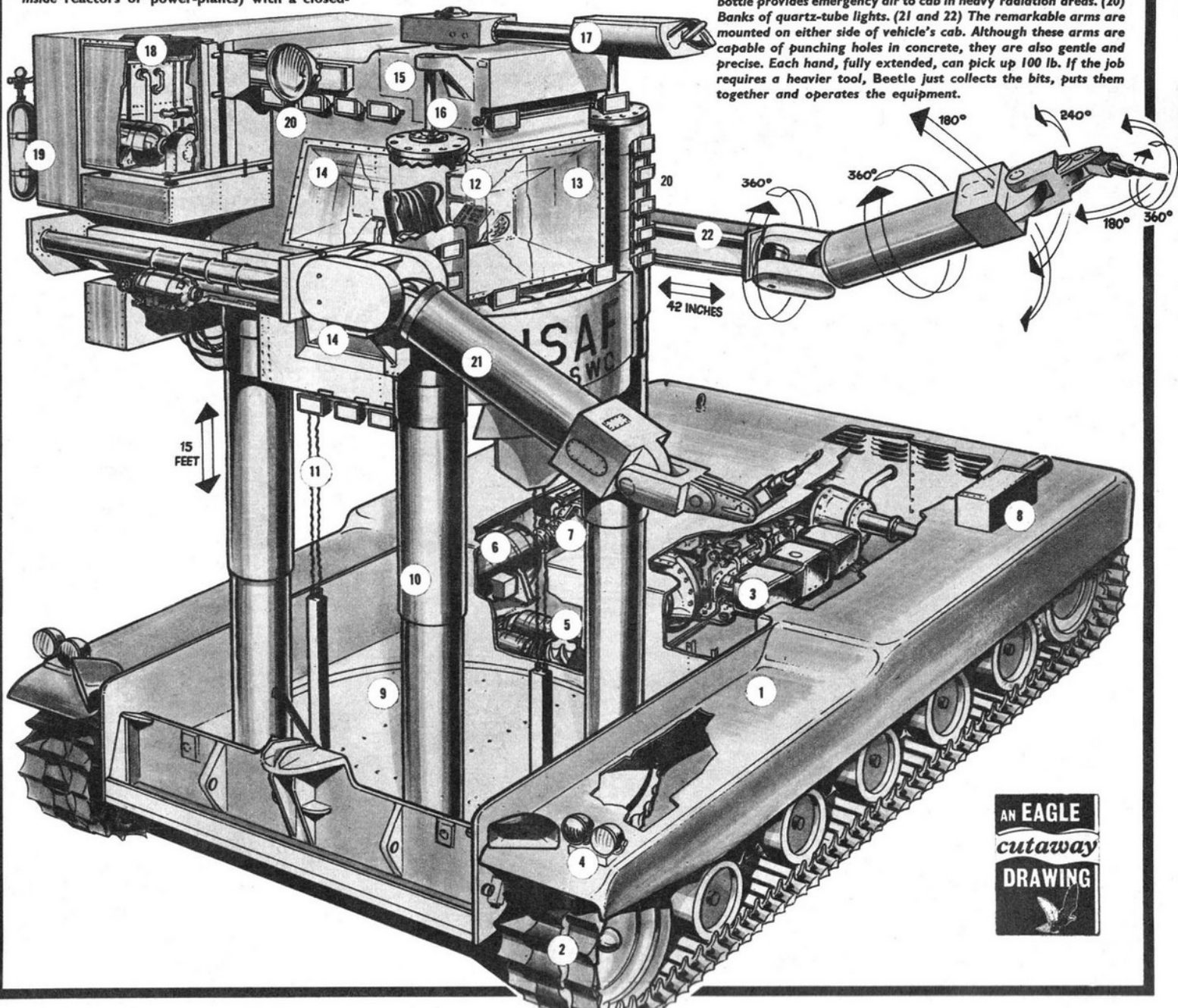
circuit TV camera. With one of its hands, it simply plucks the camera from a special 'breast pocket' and points it at the object of interest. The picture appears on a screen inside the cab.

The Beetle's mechanical arms consist of a shoulder, upper arm, elbow, forearm, wrist assembly and hand.

An electrical 'creep-drive' system is provided for positioning and can be used to move the vehicle out of a radiation field. The Beetle can also rescue another vehicle by towing it.

Two microphones allow the operator to listen to the sound of his engines, and a public-address system lets him talk to people outside, or sound an alarm siren.

(1) Whole unit is built on a tank-type chassis. Dimensions: Length 19 feet, width 12 feet 6 inches, height 10 feet. Maximum speed 10 m.p.h. (2) Advanced-design tank tracks give only 55 lb. per square inch ground pressure—only a fraction of the sq. in. pressure made by a lady's stiletto heel! (3) Main travelling power comes from a Continental six cylinder 500 h.p. engine with fuel injection and supercharger. (4) Flashing red and white lights indicate 'state' of vehicle—whether radio-active or clean. (5) Electric motors and gears used to drive the turntable. (6) A.C. generator provides all systems with electrical power. (7) Auxiliary engine driving generator and hydraulic pump. (8) Rear-view TV camera gives operator an all-round view. (9) Turntable platform spins whole cab unit 360 degrees. (10) Four hydraulic lifting rams raise and lower cab. (11) Cables taking electrical power to cab. (12) Operator sits in small but comfortable cab with a series of TV screens and controls. He has a six-position seat and a two-way radio. All systems are operated from the cab and altogether 400 miles of wiring are installed in Beetle. (13) Special windows protect the operator from radiation. Each of the windows is 24 inches thick! This one weighs 2 tons. (14) Two side windows, which weigh 1 ton each. Twenty-four inches of this glass wards off deadly gamma rays which would normally only be stopped by 5 feet of solid concrete. On outside, thin metallic film is attached to the glass. When electrically-charged, this prevents misting. (15) The entry and exit hatch is a 7½-ton unit. In case of accident, three separate systems are built in to open the door. (16) The main means of opening the heavy hatch is by a pair of hydraulic pistons operated from inside or outside. (17) An added aid is a pair of periscopes. These move 180 degrees horizontally and 170 degrees vertically. (18) A 3½-ton air-conditioning plant keeps the interior of Beetle at between 72-76 degrees. (19) Oxygen bottle provides emergency air to cab in heavy radiation areas. (20) Banks of quartz-tube lights. (21 and 22) The remarkable arms are mounted on either side of vehicle's cab. Although these arms are capable of punching holes in concrete, they are also gentle and precise. Each hand, fully extended, can pick up 100 lb. If the job requires a heavier tool, Beetle just collects the bits, puts them together and operates the equipment.



AN EAGLE  
cutaway  
DRAWING



# CATHEDRAL

# FOR THE SPACE AGE

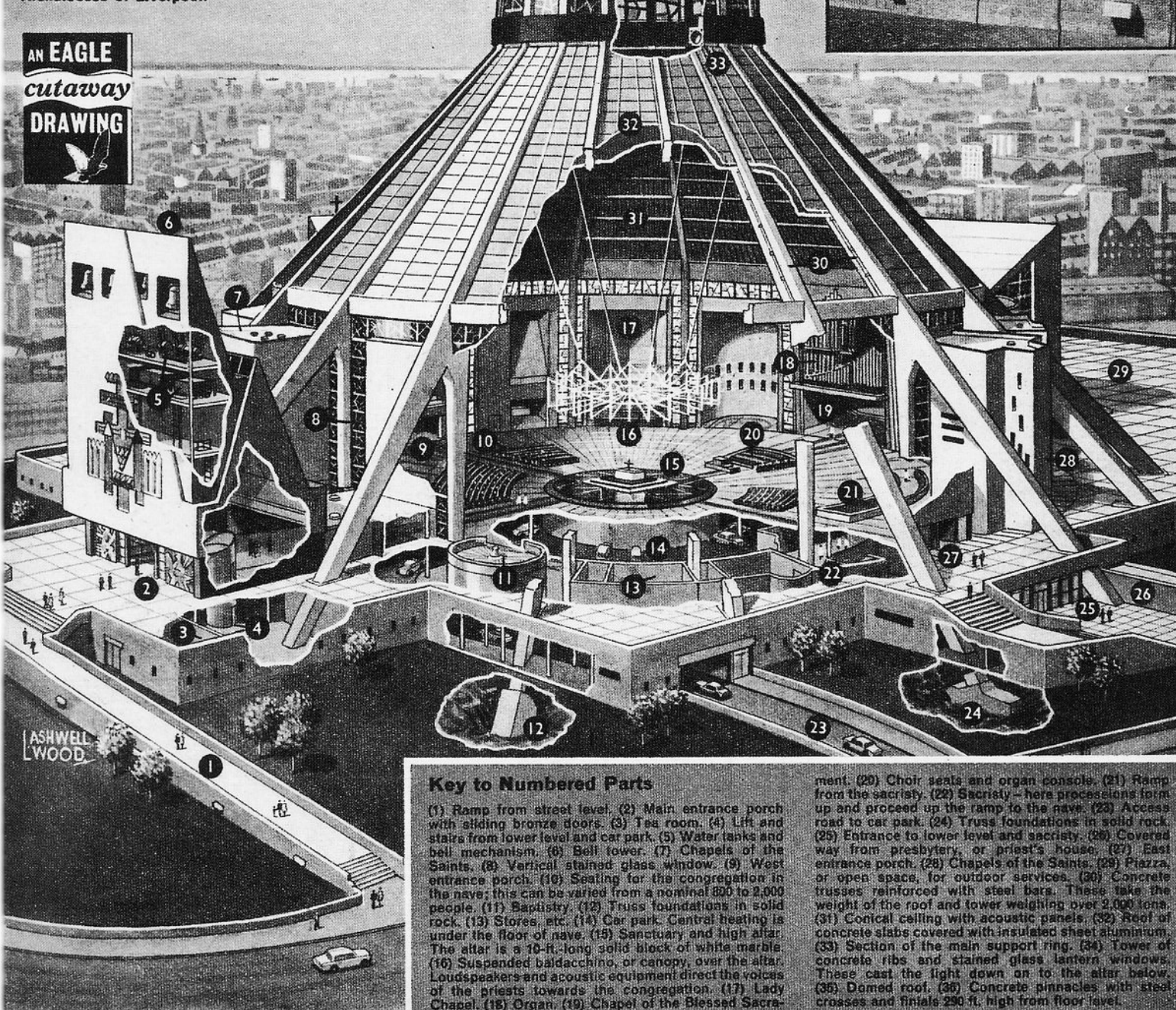
Towering 290 ft. above Brownlow Hill in the centre of Liverpool stands the new Metropolitan Cathedral of Christ the King. Bold and striking in design, this cathedral is built from modern materials and has been planned to last at least 500 years.

The main structure takes the form of a cone, composed of sixteen massive radial trusses of concrete reinforced with steel bars, surmounted by a tapering tower, or lantern, with stained glass panels. Above this rise 60-ft.-high pinnacles with their steel crosses and finials.

Between the trusses are placed sixteen smaller buildings, including chapels. These form the vertical walls of the building. Facing south is the main entrance porch and 90-ft.-high bell tower. Inside is the vast circular nave, 195 ft. in diameter, with the sanctuary and high altar placed in the centre. At the northern end is the organ and principal Chapel of the Blessed Sacrament.

One of the most remarkable features of this unique building is the central car park, deep in the heart of the cathedral under the nave, with an entrance road from the street.

The cathedral, which was formally opened or consecrated on 14th May this year, after nearly five years of building at a cost of £2½ million, was built for the Trustees of the Roman Catholic Archdiocese of Liverpool.



## Key to Numbered Parts

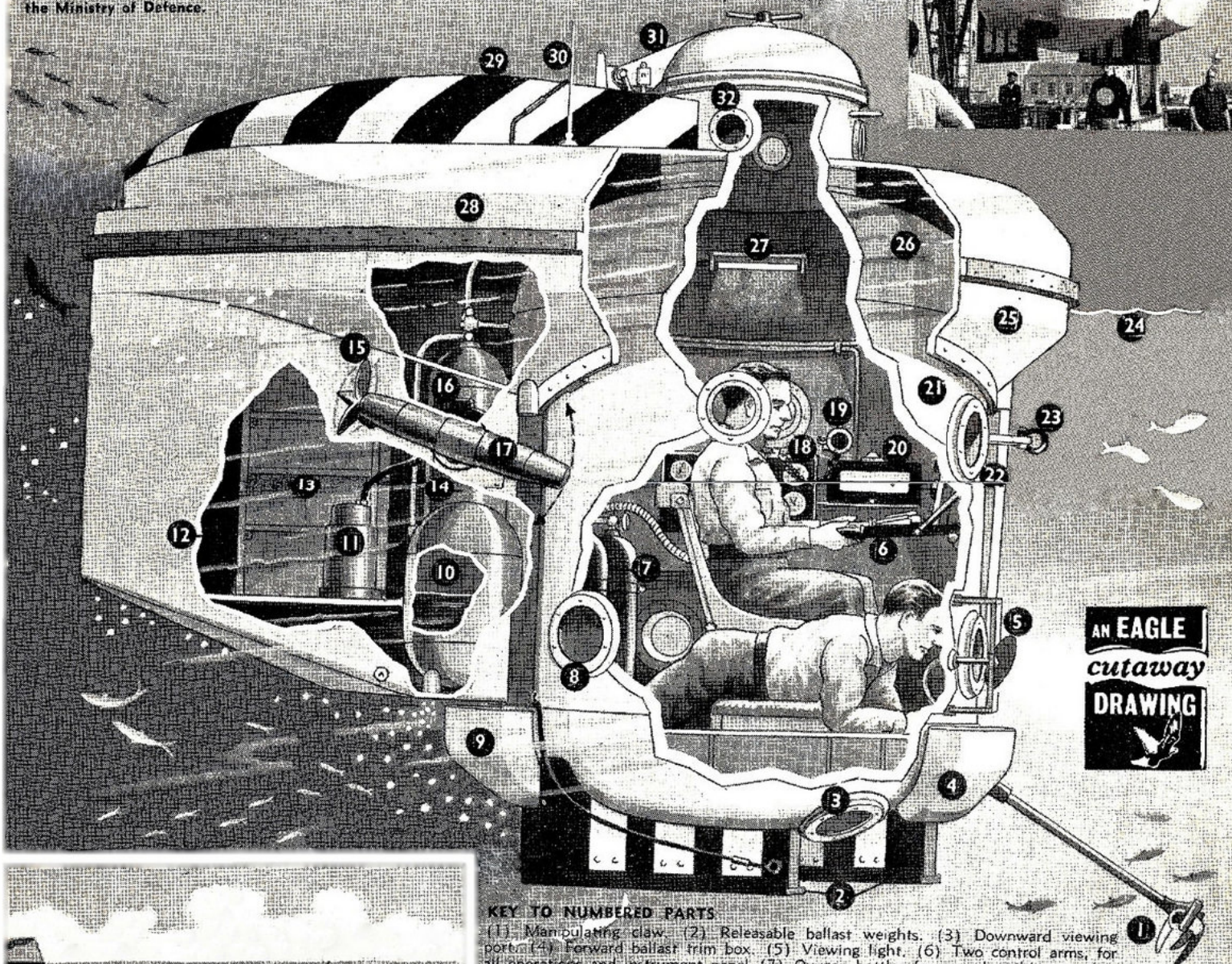
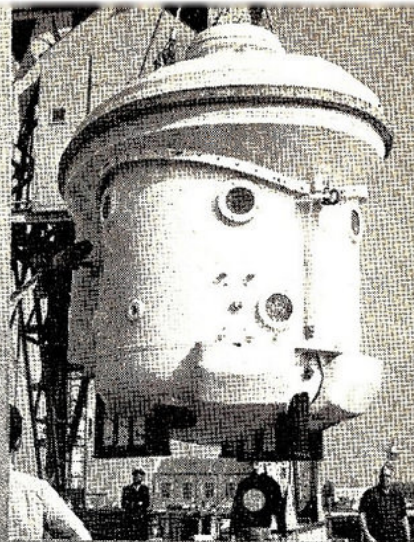
(1) Ramp from street level. (2) Main entrance porch with sliding bronze doors. (3) Tea room. (4) Lift and stairs from lower level and car park. (5) Water tanks and bell mechanism. (6) Bell tower. (7) Chapels of the Saints. (8) Vertical stained glass window. (9) West entrance porch. (10) Seating for the congregation in the nave; this can be varied from a nominal 600 to 2,000 people. (11) Baptistry. (12) Truss foundations in solid rock. (13) Stores, etc. (14) Car park. Central heating is under the floor of nave. (15) Sanctuary and high altar. The altar is a 10-ft.-long solid block of white marble. (16) Suspended baldachin, or canopy, over the altar. Loudspeakers and acoustic equipment direct the voices of the priests towards the congregation. (17) Lady Chapel. (18) Organ. (19) Chapel of the Blessed Sacra-

ment. (20) Choir seats and organ console. (21) Ramp from the sacristy. (22) Sacristy - here processions form up and proceed up the ramp to the nave. (23) Access road to car park. (24) Truss foundations in solid rock. (25) Entrance to lower level and sacristy. (26) Covered way from presbytery, or priest's house. (27) East entrance porch. (28) Chapels of the Saints. (29) Piazza, or open space, for outdoor services. (30) Concrete trusses reinforced with steel bars. These take the weight of the roof and tower weighing over 2,000 tons. (31) Conical ceiling with acoustic panels. (32) Roof of concrete slabs covered with insulated sheet aluminium. (33) Section of the main support ring. (34) Tower of concrete ribs and stained glass lantern windows. These cast the light down on to the altar below. (35) Domed roof. (36) Concrete pinnacles with steel crosses and finials 290 ft. high from floor level.



# BRITAIN'S FIRST UNDERSEA CRAFT

Known as a Standard Underwater Research Vessel, this two-man submarine is capable of working at depths of up to 1,000 ft. for sea-bed exploration. Its many uses will include underwater surveys for the laying of new gas pipelines, oil pipelines and telephone cables. Geologists will be able to study the sea-beds for off-shore gravel and mineral deposits. Marine Biologists will study undersea life and provide information about fish movements, etc. The working depth of 1,000 ft. brings observation of the Continental Shelf around our coasts and about half the world's ocean beds within reach. S.U.R.V. is roomy, the two operators being able to move about under atmosphere pressure in a large steel pressure hull. There are ten Perspex glass viewing ports in the hull and provision is made for cameras and cine-cameras; also a manipulating arm or claw for picking up specimens. Two electric motors of 2½ h.p. each, one each side of the vessel, can be rotated through 100 degrees to drive the craft in any direction at a speed of 2½ knots. Those can be used for descending to the sea-bed, ascending and forward and reverse travel. The craft weighs 6 tons and was built by Limtett Engineering at Horsham, Sussex, in co-operation with the Ministry of Defence.



AN EAGLE  
cutaway  
DRAWING

## KEY TO NUMBERED PARTS

(1) Manipulating claw. (2) Releasable ballast weights. (3) Downward viewing port. (4) Forward ballast trim box. (5) Viewing light. (6) Two control arms, for all operations and instrument panel. (7) Oxygen bottles for crew breathing requirements. Carbon-dioxide is absorbed by soda lime containers. (8) Viewing port. (9) Rear ballast trim box. (10) Buoyancy trim tanks (each side). Sea water is admitted at will and compressed air is used to blow it out. (11) Inverter for converting the D.C. current from the batteries to A.C. current for the propulsion motors. (12) Free flooding area. (13) Batteries of 146 volts in pressure-proof pods. (14) Compressed air cylinder for blowing buoyancy tanks. (15) Three-bladed propellers (each side). (16) Electric propulsion motors in pressure-proof casing. (17) Each propeller unit can rotate through 100 degrees. (18) Instrument panel for gyro-compass, turn indicator, oxygen flow control, ballast release, etc. (19) Two-way through water ultrasonic speech microphone. (20) Electric depth indicator from the sea-bed or from the surface. (21) Steel pressure hull, designed to withstand sea pressure of over 600 pounds per square inch. (22) Forward viewing port. (23) Towing eye. (24) Position of water level when craft is on the surface. (25) Free flooding area surrounding the pressure hull. (26) Free flooding area when submerged; when surfacing this surround is blown free of water to give surface buoyancy. (27) Fluorescent lighting. (28) Fibre-glass surround. (29) Surface identification markings. (30) Ultrasonic speech aerial. (31) Entrance hatch. (32) Hatch viewing ports. (33) (Below) Submarine telephone cable.

The Continental Shelf (A), which the undersea craft will explore, lying next to the land and sloping to 1,000 ft. The Continental Slope (B) goes down to the Deep Sea Plain which averages about 2 miles deep — 11,560 feet.

ASHWELL  
WOOD

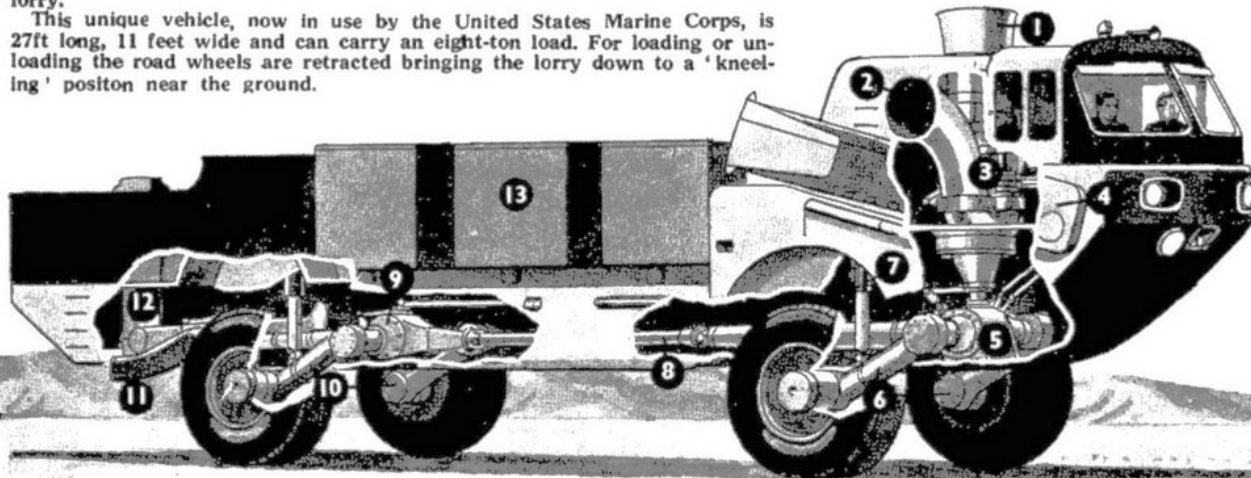


# A LORRY-A BOAT-A SKIMMER

This jet engine powered amphibian is three vehicles in one—it can go overland like a 10-ton lorry, move in water like a boat, or "skim" on hydrofoils over the water. It is powered by a 1,000 hp marine gas turbine engine in a vertical position behind the control cab. By means of gear selection power is transmitted to the four road wheels; these can be retracted upwards when the vehicle is moving in water and by engaging the correct gear the drive is transmitted to water jet propulsion units—one each side of the rear. For "skimming" two large hydrofoils are lowered at the front and a power driven one at the rear to give forward propulsion. The foils and struts retract into the hull when the vehicle is used as a boat or a road lorry.

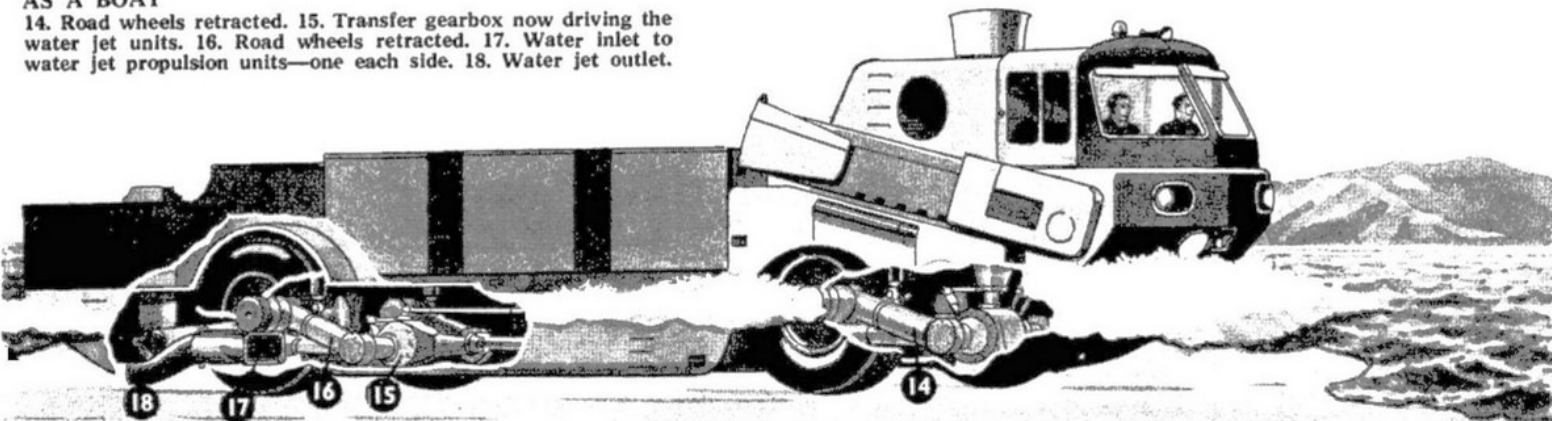
This unique vehicle, now in use by the United States Marine Corps, is 27ft long, 11 feet wide and can carry an eight-ton load. For loading or unloading the road wheels are retracted bringing the lorry down to a 'kneeling' position near the ground.

**AS A LAND VEHICLE**  
1. Jet exhaust outlet. 2. Engine air inlet—both sides. 3. 1,000 hp gas turbine jet engine. 4. Front hydrofoils retracted both sides. 5. Transfer gearbox drive to road wheels, water jet units and rear hydrofoil. 6. Road wheel drive lowered. 7. Hydraulic jacks. 8. Drive shaft to rear wheels, water jet units and rear hydrofoil. 9. Rear transfer gear box. 10. Road wheel drive lowered. 11. Water jet propulsion unit. 12. Rear hydrofoil retracted. 13. Side loading doors.



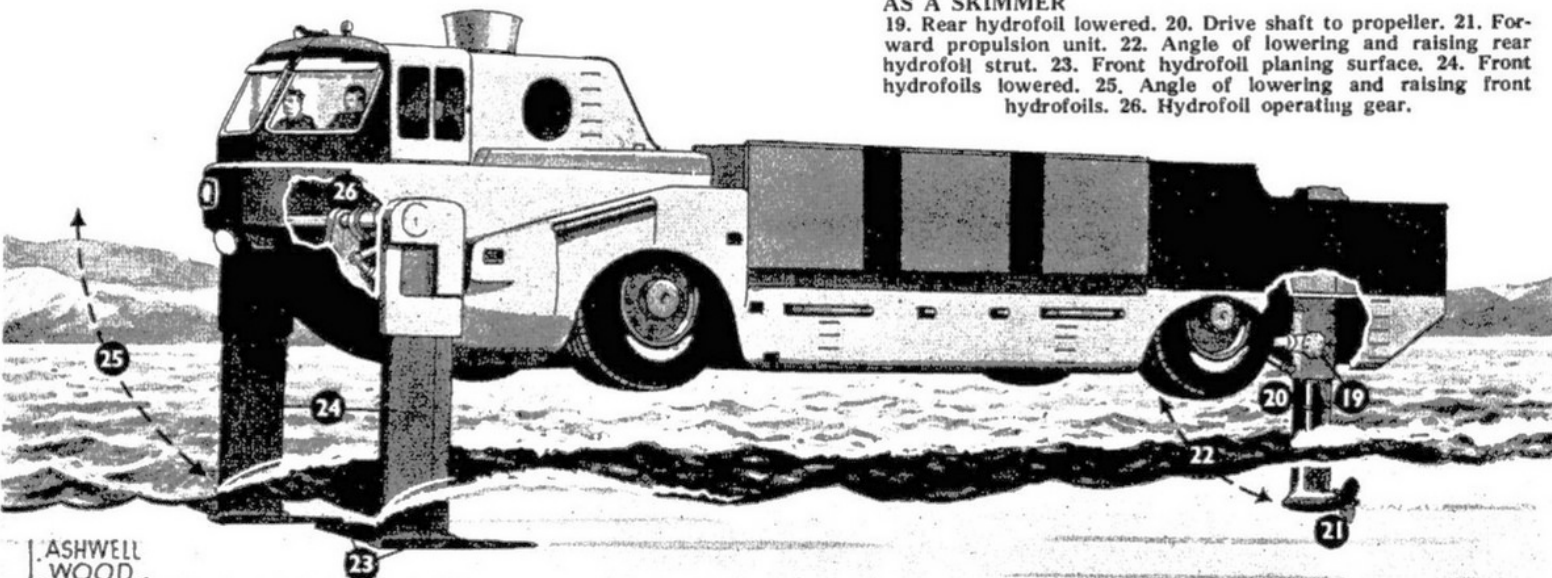
## AS A BOAT

14. Road wheels retracted. 15. Transfer gearbox now driving the water jet units. 16. Road wheels retracted. 17. Water inlet to water jet propulsion units—one each side. 18. Water jet outlet.



## AS A SKIMMER

19. Rear hydrofoil lowered. 20. Drive shaft to propeller. 21. Forward propulsion unit. 22. Angle of lowering and raising rear hydrofoil strut. 23. Front hydrofoil planing surface. 24. Front hydrofoils lowered. 25. Angle of lowering and raising front hydrofoils. 26. Hydrofoil operating gear.





The fifteenth warship of the Royal Navy to be so named, *H.M.S. Eagle* is Britain's largest and latest aircraft carrier. In this issue of *EAGLE*, we exclusively introduce the first drawing of her external modernization features - her new radar aerials, angled deck and steam catapults.

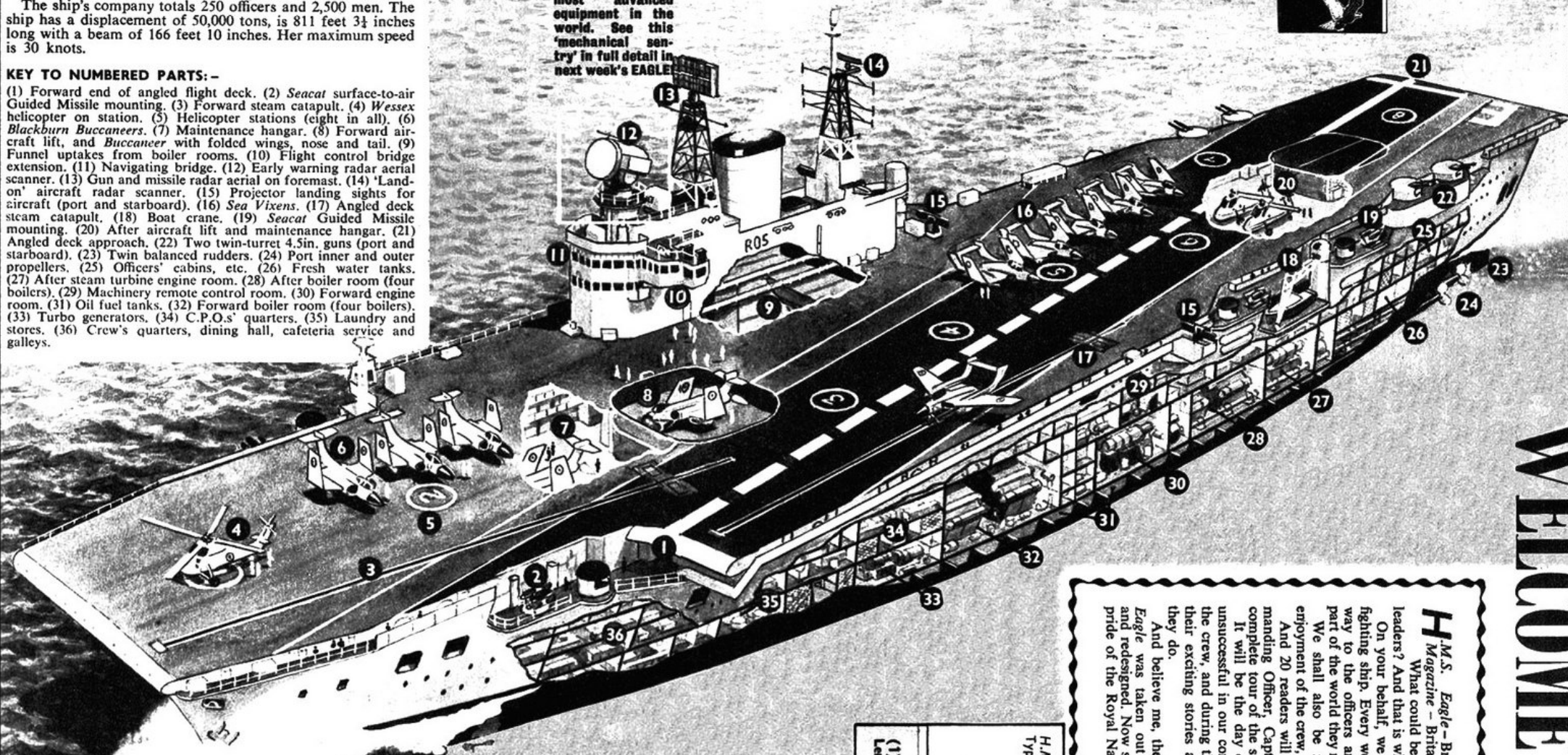
Other modern features include the 3D radar in conjunction with A.D.A. (Action Data Automation) - an automatic computer system, the complex 'brain' of which handles all radar information to control the ship's aircraft.

The ship's company totals 250 officers and 2,500 men. The ship has a displacement of 50,000 tons, is 811 feet 3 1/2 inches long with a beam of 166 feet 10 inches. Her maximum speed is 30 knots.

#### KEY TO NUMBERED PARTS:-

(1) Forward end of angled flight deck. (2) *Seacat* surface-to-air Guided Missile mounting. (3) Forward steam catapult. (4) *Wessex* helicopter on station. (5) Helicopter stations (eight in all). (6) *Blackburn Buccaneers*. (7) Maintenance hangar. (8) Forward aircraft lift, and *Buccaneer* with folded wings, nose and tail. (9) Funnel uptakes from boiler rooms. (10) Flight control bridge extension. (11) Navigating bridge. (12) Early warning radar aerial scanner. (13) Gun and missile radar aerial on foremast. (14) 'Land-on' aircraft radar scanner. (15) Projector landing sights for aircraft (port and starboard). (16) *Sea Vixens*. (17) Angled deck steam catapult. (18) Boat crane. (19) *Seacat* Guided Missile mounting. (20) After aircraft lift and maintenance hangar. (21) Angled deck approach. (22) Two twin-turret 4.5in. guns (port and starboard). (23) Twin balanced rudders. (24) Port inner and outer propellers. (25) Officers' cabins, etc. (26) Fresh water tanks. (27) After steam turbine engine room. (28) After boiler room (four boilers). (29) Machinery remote control room. (30) Forward engine room. (31) Oil fuel tanks. (32) Forward boiler room (four boilers). (33) Turbo generators. (34) C.P.O.s' quarters. (35) Laundry and stores. (36) Crew's quarters, dining hall, cafeteria service and galleys.

This radar scanner is *H.M.S. Eagle's* watchdog against attackers. It is the most advanced equipment in the world. See this 'mechanical sentry' in full detail in next week's *EAGLE*.



# WELCOME ABOARD

*H.M.S. Eagle* - Britain's finest aircraft carrier. *EAGLE Magazine* - Britain's finest boys' paper.

What could be more natural than a link between these two leaders? And that is what we have done.

On your behalf, we have 'adopted' Britain's biggest and newest fighting ship. Every week, copies of your magazine will find their way to the officers and crew of *H.M.S. Eagle*, no matter what part of the world they may be in.

We shall also be making a presentation of canoes for the enjoyment of the crew, on or off duty.

And 20 readers will have the opportunity of meeting the Commanding Officer, Captain L. D. Empson, and being taken on a complete tour of the ship.

It will be the day of a lifetime. But for those boys who are unsuccessful in our competition, we shall be interviewing many of the crew, and during the next few weeks we shall be bringing you their exciting stories and telling you something about the work they do.

And believe me, their work is really exciting. In 1959, *H.M.S. Eagle* was taken out of commission to be completely refitted and redesigned. Now she is being prepared for her trip - truly the pride of the Royal Navy.

#### H.M.S. EAGLE AIRCRAFT LINE-UP

Types carried at present - each to scale



(1) Blackburn Buccaneer S.1. Strike aircraft - Length 63ft. 5in.



(2) Hawker Siddeley Sea Vixen A.W.F.L. All-weather fighter - Length 53ft. 6in.



(3) Westland Wessex A.S.1. Anti-submarine helicopter - Length 45ft. 6in.



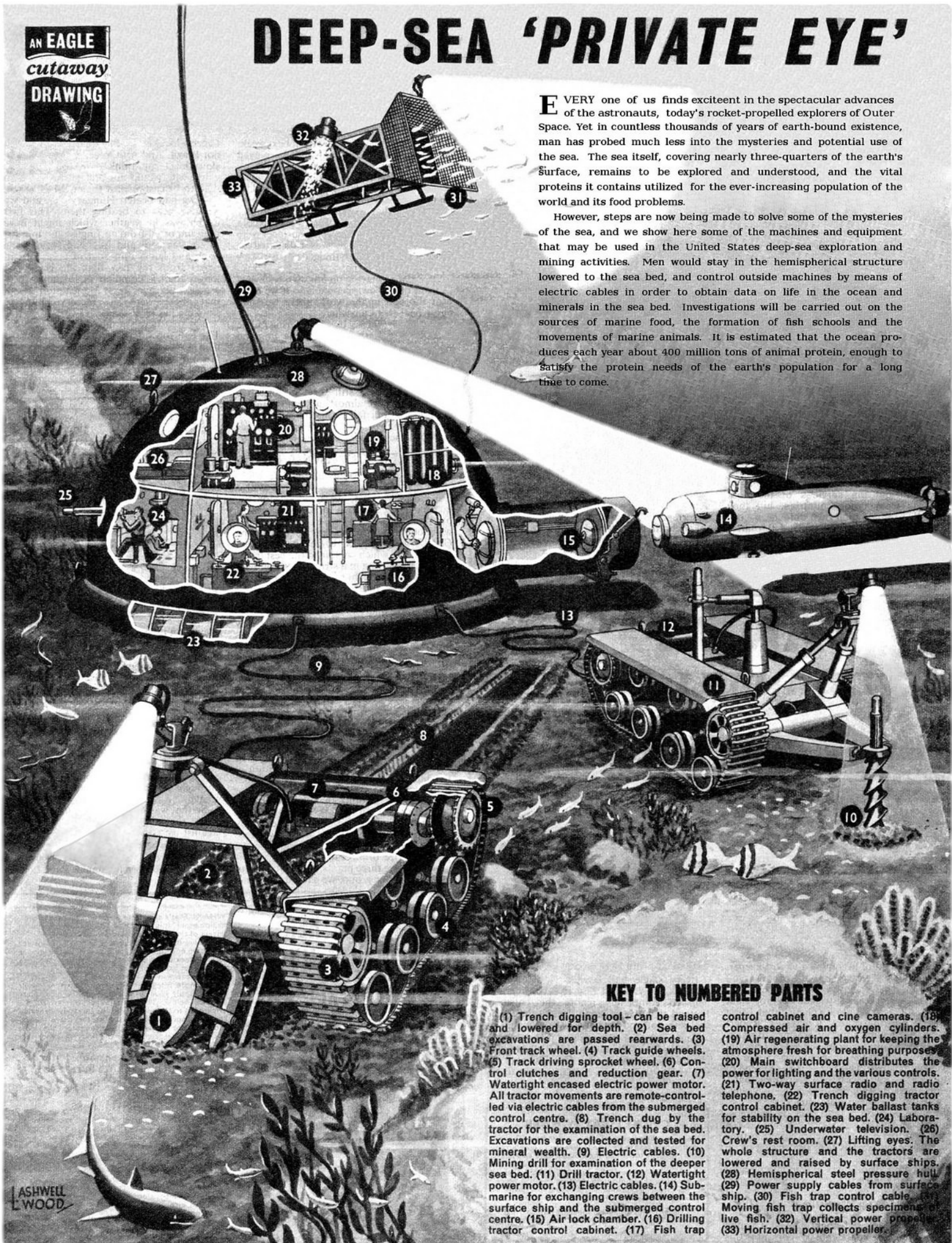
(4) Fairey Gannet A.E.W.3. Airborne early warning - length 44ft.



# DEEP-SEA 'PRIVATE EYE'

EVERY one of us finds excitement in the spectacular advances of the astronauts, today's rocket-propelled explorers of Outer Space. Yet in countless thousands of years of earth-bound existence, man has probed much less into the mysteries and potential use of the sea. The sea itself, covering nearly three-quarters of the earth's surface, remains to be explored and understood, and the vital proteins it contains utilized for the ever-increasing population of the world and its food problems.

However, steps are now being made to solve some of the mysteries of the sea, and we show here some of the machines and equipment that may be used in the United States deep-sea exploration and mining activities. Men would stay in the hemispherical structure lowered to the sea bed, and control outside machines by means of electric cables in order to obtain data on life in the ocean and minerals in the sea bed. Investigations will be carried out on the sources of marine food, the formation of fish schools and the movements of marine animals. It is estimated that the ocean produces each year about 400 million tons of animal protein, enough to satisfy the protein needs of the earth's population for a long time to come.



## KEY TO NUMBERED PARTS

- (1) Trench digging tool - can be raised and lowered for depth. (2) Sea bed excavations are passed rearwards. (3) Front track wheel. (4) Track guide wheels. (5) Track driving sprocket wheel. (6) Control clutches and reduction gear. (7) Watertight encased electric power motor. All tractor movements are remote-controlled via electric cables from the submerged control centre. (8) Trench dug by the tractor for the examination of the sea bed. Excavations are collected and tested for mineral wealth. (9) Electric cables. (10) Mining drill for examination of the deeper sea bed. (11) Drill tractor. (12) Watertight power motor. (13) Electric cables. (14) Submarine for exchanging crews between the surface ship and the submerged control centre. (15) Air lock chamber. (16) Drilling tractor control cabinet. (17) Fish trap control cabinet and cine cameras. (18) Compressed air and oxygen cylinders. (19) Air regenerating plant for keeping the atmosphere fresh for breathing purposes. (20) Main switchboard distributes the power for lighting and the various controls. (21) Two-way surface radio and radio telephone. (22) Trench digging tractor control cabinet. (23) Water ballast tanks for stability on the sea bed. (24) Laboratory. (25) Underwater television. (26) Crew's rest room. (27) Lifting eyes. The whole structure and the tractors are lowered and raised by surface ships. (28) Hemispherical steel pressure hull. (29) Power supply cables from surface ship. (30) Fish trap control cable. (31) Moving fish trap collects specimens of live fish. (32) Vertical power propeller. (33) Horizontal power propeller.



# DEEP-SEA PROBE

What is the most efficient method of deep-sea fishing? The answer will be found when this special submarine gets to work in 12 months' time. One of a pair, it will be used by scientists to study the movements of fish and the techniques and tackle used by fishermen. With whirling cameras and glaring searchlights, the sub looks like a Jules Verne creation, but it will give man his first chance to look at the fish in their natural surroundings. Underwater cameras and a hundred and one other gadgets will make the sub the most useful fishing invention since the powered trawler.

Gas-turbine engines will provide the power when on the surface and also charge the electric motors used underwater. Designers are hoping to fit ten men into each 50-foot-long sub, which will have an underwater speed of 7 knots.

Two stumpy legs protrude from the pressure hull - allowing the craft to sit on the ocean bed when studying marine life.

## KEY TO NUMBERED PARTS

(1) Radio aerial. (2) Crew hatch. (3) Free-flooding superstructure. (4) Forward lights. (5) Forward diving hydroplane. (6 and 7) Observation windows and cameras. (8) Laboratory. (9) Watertight door. (10) 'Legs' - enabling the vessel to rest on the ocean bed. (11) Batteries for electric motor. (12) Instrument and control panels. (13) Upper observation position. (14) Diving hydroplane control. (15) Observation window, cameras and lights. (16) Oxygen bottles. (17) Observation light. (18) Pressure hull. (19) Ballast tanks. (20) Ballast tanks, filled with sea water for submerging, blown by compressed air for surfacing. (21) Compressed air storage cylinders. (22) Air duct to engine. (23) Engine

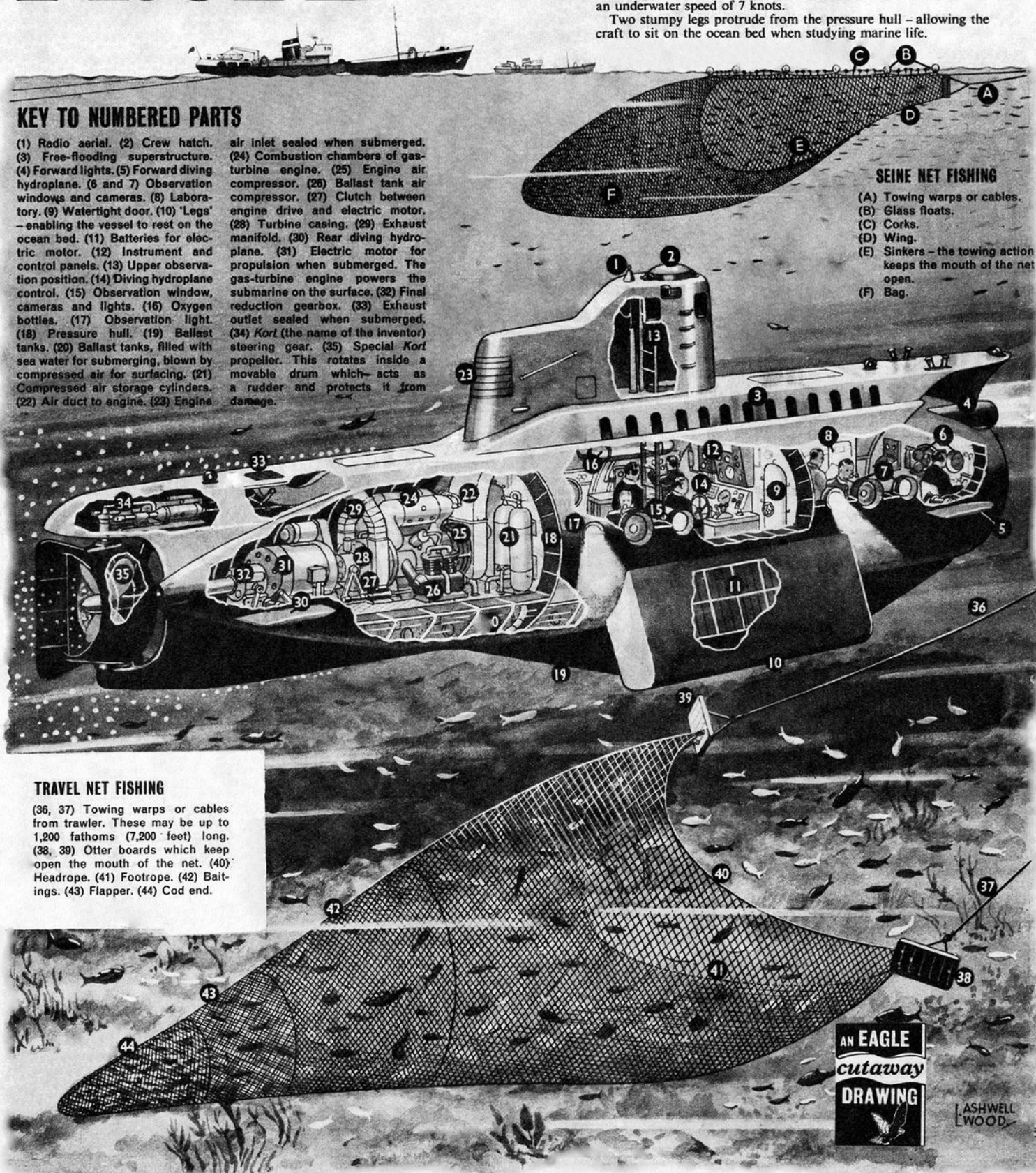
air inlet sealed when submerged. (24) Combustion chambers of gas-turbine engine. (25) Engine air compressor. (26) Ballast tank air compressor. (27) Clutch between engine drive and electric motor. (28) Turbine casing. (29) Exhaust manifold. (30) Rear diving hydroplane. (31) Electric motor for propulsion when submerged. The gas-turbine engine powers the submarine on the surface. (32) Final reduction gearbox. (33) Exhaust outlet sealed when submerged. (34) Kort (the name of the inventor) steering gear. (35) Special Kort propeller. This rotates inside a movable drum which acts as a rudder and protects it from damage.

## SEINE NET FISHING

(A) Towing warps or cables. (B) Glass floats. (C) Corks. (D) Wing. (E) Sinkers - the towing action keeps the mouth of the net open. (F) Bag.

## TRAWL NET FISHING

(36, 37) Towing warps or cables from trawler. These may be up to 1,200 fathoms (7,200 feet) long. (38, 39) Otter boards which keep open the mouth of the net. (40) Headrope. (41) Footrope. (42) Baitings. (43) Flapper. (44) Cod end.



AN EAGLE  
cutaway  
DRAWING

LASHWELL  
WOOD



# AN ATOMIC-POWERED BOMBER

You will not find this aircraft in any spotters' book, for it is our artist's impression, exclusive to EAGLE, of an atomic aircraft of the not too distant future.

It is based on scientific facts and indeed on practical experimental work now in progress on atomic energy for the propulsion of aircraft. The American Air Force have given orders for a fleet of atomic-powered bombers to be built in due course.

The atomic engines will be similar to our present jets, but with the difference that the air, instead of being mixed with fuel and ignited, will be passed through a heat exchanger heated by an atomic reactor. Here the temperature of the air will be raised to something like 2,000 degrees F., which will then expand with terrific explosive force, thus driving the turbine wheel, and create the necessary jet thrust.

Another tremendous advantage is that a few ounces of Uranium '235', the fuel, would drive the aircraft more than once round the world without refuelling.

## KEY TO ATOMIC-JET ENGINES

(1) Atomic or nuclear reactor and inner shielding. (2) Tubes of Uranium '235', the fuel, which generates enormous heat. (3) Control rods. (4) Control rod motor. (5) Circulating 'heavy water' coolant, called Deuterium or D 20. This draws off the heat. (6) Coolant passing through heat exchanger. (7) Circulating pumps. (8) Coolant ducts to starboard engines. (9-9) Outer shielding to prevent radiation. (10) Air inlets to compressor. (11) Axial flow air compressor. (12) Compressed air flows through heat exchanger and the temperature is raised to 2,000 degrees F. (13) Turbine wheel driven by hot expanding air. This turbine drives the air compressor. (14) Cone against which the jet thrust reacts. (15) Jet pipe and exhaust nozzle.

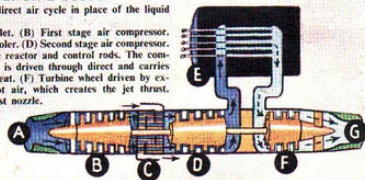
## KEY TO OTHER PARTS

(16) Port main undercarriage retracted. (17-17) Air brakes. (18) Swept-back fin and rudder. (19) Port elevator. (20) Port aileron. (21) Combination of delta and crescent-shaped wing. (22) Air-to-air guided missile being fired from port wing. (23) Air-to-ground guided missiles. (24) Fuselage undercarriage retracted. (25) Controls to reactor control rod motor. (26) Aircraft controls. (27) Air-to-ground guided missiles. (28) Supplementary shielding for crew. (29) Retractable stabilizers, or trimmers. (30) Electronics compartment for guided missiles. (31) Radio-operator and navigator. (32) Captain and co-pilot. (33) Bomb-aimer's window. (34) Secret radar gear and guided missile control.

## AN ALTERNATIVE ATOMIC-JET ENGINE SYSTEM

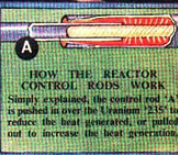
This is a direct air cycle in place of the liquid circuit.

(A) Air inlet. (B) First stage air compressor. (C) Intercooler. (D) Second stage air compressor. (E) Atomic reactor and control rods. The compressed air is driven through direct and carries off great heat. (F) Turbine wheel driven by expanding hot air, which creates the jet thrust. (G) Exhaust nozzle.



## HOW THE REACTOR CONTROL RODS WORK

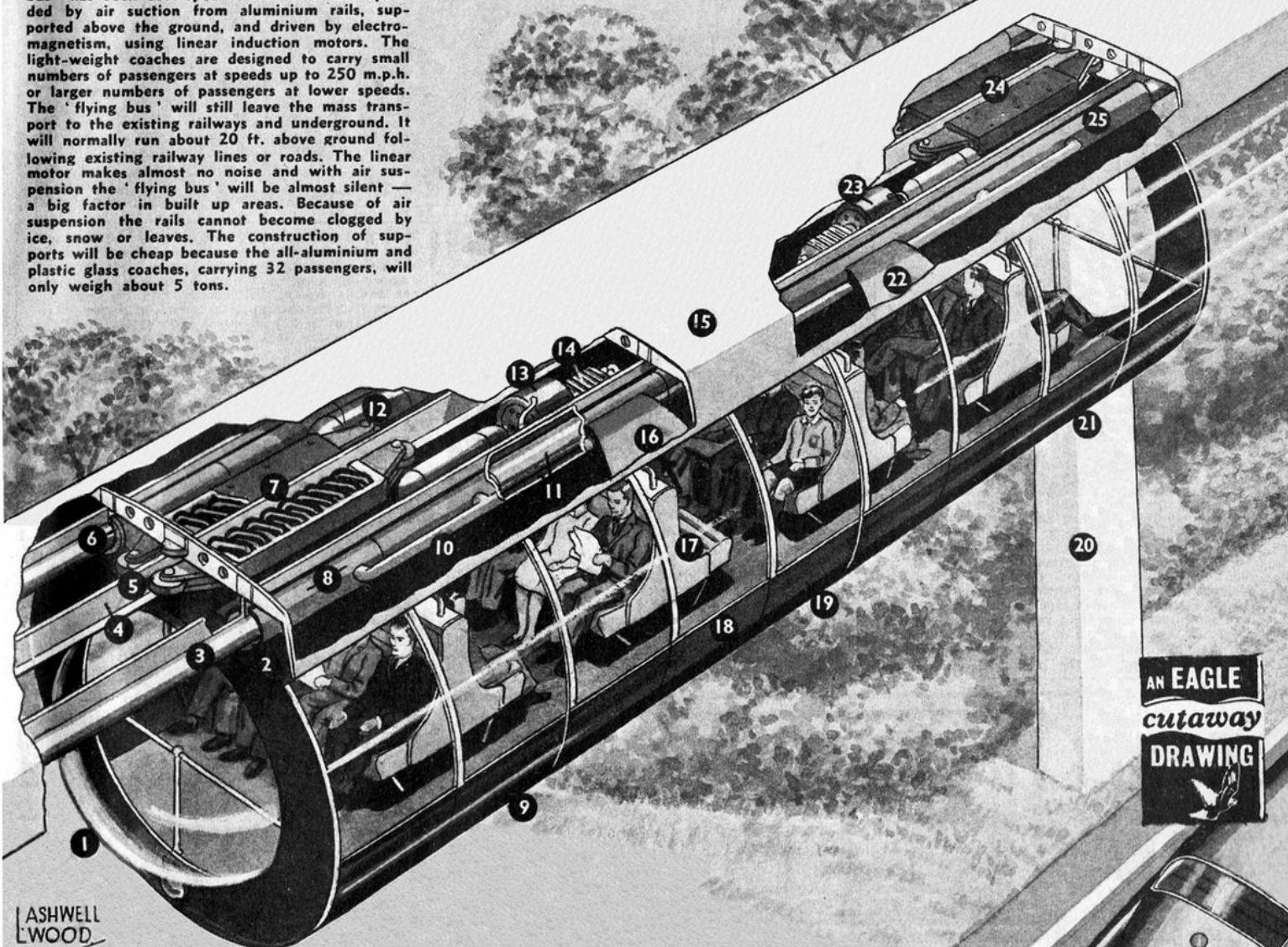
Simply explained, the control rod 'A' is pushed in over the Uranium '235' to reduce the heat generated, or pulled out to increase the heat generation.





# HOP ON A 'FLYING BUS'

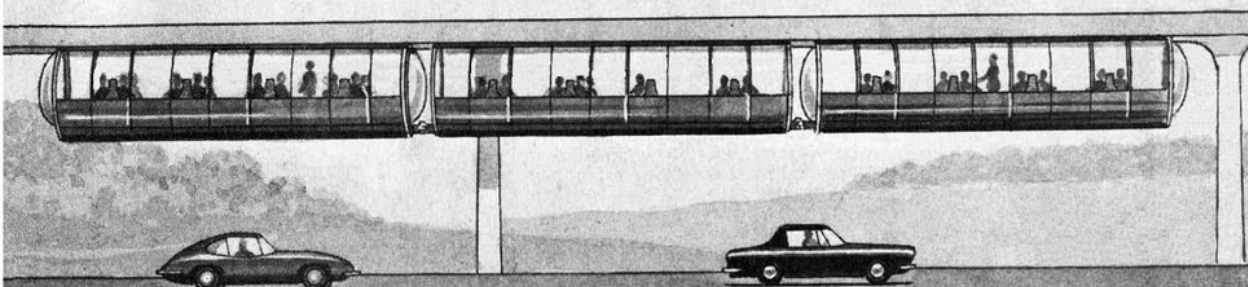
A revolutionary type of transport called a 'flying bus' has been developed in France. It is suspended by air suction from aluminium rails, supported above the ground, and driven by electro-magnetism, using linear induction motors. The light-weight coaches are designed to carry small numbers of passengers at speeds up to 250 m.p.h. or larger numbers of passengers at lower speeds. The 'flying bus' will still leave the mass transport to the existing railways and underground. It will normally run about 20 ft. above ground following existing railway lines or roads. The linear motor makes almost no noise and with air suspension the 'flying bus' will be almost silent — a big factor in built up areas. Because of air suspension the rails cannot become clogged by ice, snow or leaves. The construction of supports will be cheap because the all-aluminium and plastic glass coaches, carrying 32 passengers, will only weigh about 5 tons.



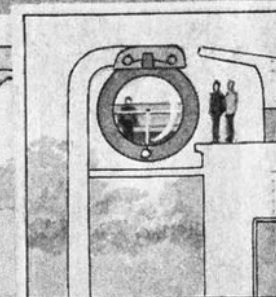
AN EAGLE  
cutaway  
DRAWING

## KEY TO NUMBERED PARTS

(1) Plastic glass observation nose. (2) Air suspension duct. (3) Aluminium suspension rail. (4) Insulated plate 'rotor' rail. (5) Plate centring wheels. (6) Suspension rail and air seal. (7) Linear motor — a relatively simple machine that has no moving parts. The 'Stator' consists of two sets of coils in iron blocks, fixed to the vehicle. It draws itself along the plate 'rotor' rail by electro-magnetism, the rail actually forming part of the motor. (8) Air cushion trunk and seal. (9) Sliding door. (10) Compressed air supply ducts. (11) Suspension rail inside air cushion trunk. (12) Compressed air reservoir. (13) Electric compressor motor. (14) Two-stage air compressors. (15) Light-weight overhead support canopy. (16) Air intakes to compressor and air cushion trunk. (17) Seating for 32 passengers. (18) Light-weight aluminium plating and plastic glass coach. (19) Sliding door. (20) Light-weight supports for overhead canopy. (21) Sliding door. (22) Air intake to compressor. (23) Two-stage air compressor and motor. (24) Linear motor. (25) Air cushion trunk and suspension rail.



A 'flying bus' multi-coach unit carrying 96 passengers at 100 m.p.h.



Typical station layout



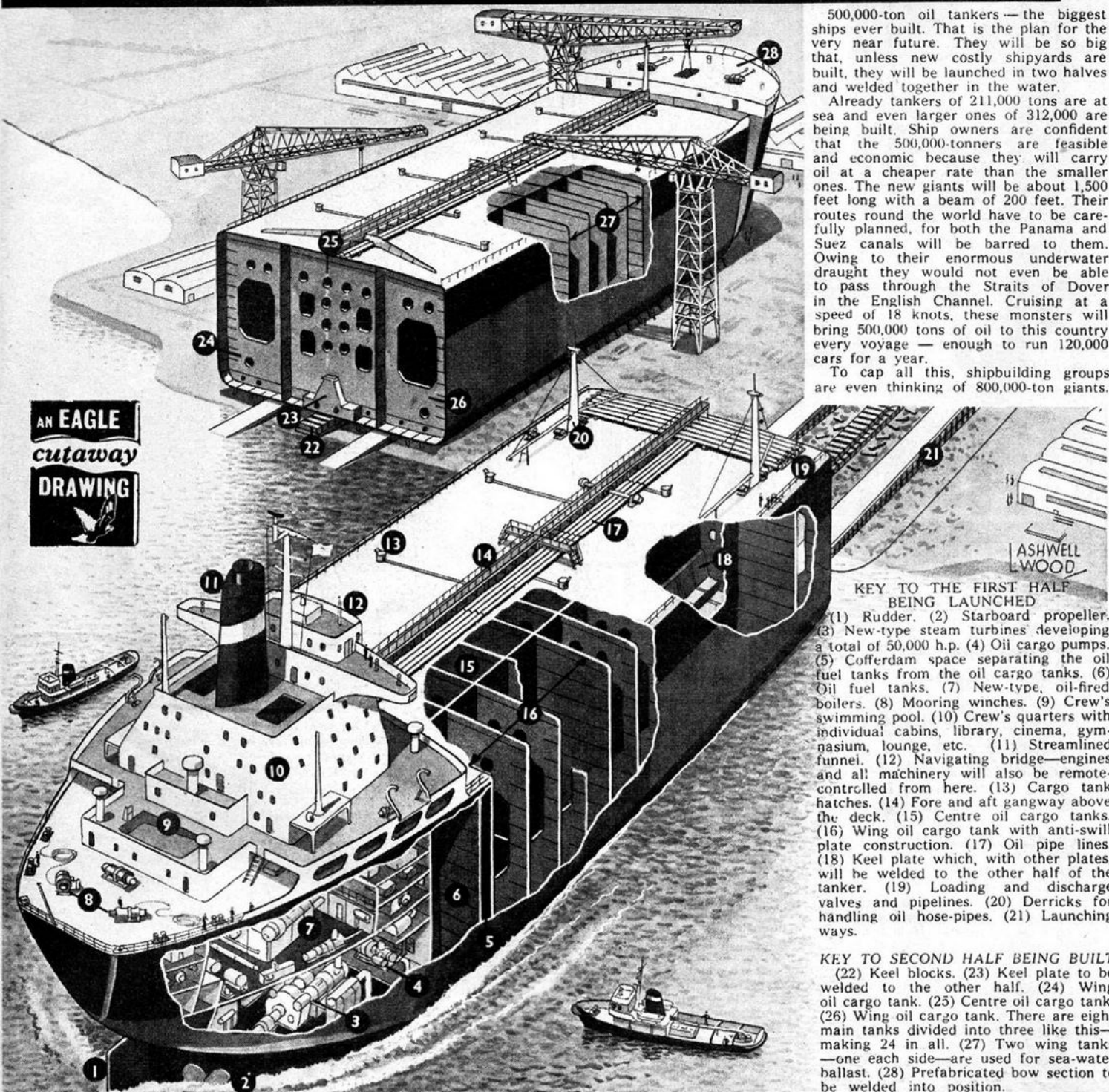
# SEA GIANTS OF THE FUTURE

500,000-ton oil tankers—the biggest ships ever built. That is the plan for the very near future. They will be so big that, unless new costly shipyards are built, they will be launched in two halves and welded together in the water.

Already tankers of 211,000 tons are at sea and even larger ones of 312,000 are being built. Ship owners are confident that the 500,000-tonners are feasible and economic because they will carry oil at a cheaper rate than the smaller ones. The new giants will be about 1,500 feet long with a beam of 200 feet. Their routes round the world have to be carefully planned, for both the Panama and Suez canals will be barred to them. Owing to their enormous underwater draught they would not even be able to pass through the Straits of Dover in the English Channel. Cruising at a speed of 18 knots, these monsters will bring 500,000 tons of oil to this country every voyage—enough to run 120,000 cars for a year.

To cap all this, shipbuilding groups are even thinking of 800,000-ton giants.

AN EAGLE  
cutaway  
DRAWING

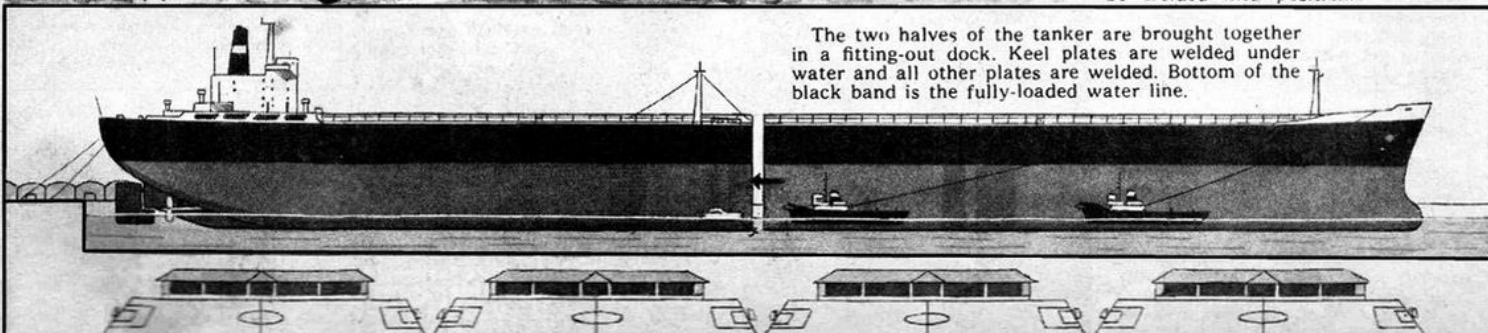


## KEY TO THE FIRST HALF BEING LAUNCHED

(1) Rudder. (2) Starboard propeller. (3) New-type steam turbines developing a total of 50,000 h.p. (4) Oil cargo pumps. (5) Cofferdam space separating the oil fuel tanks from the oil cargo tanks. (6) Oil fuel tanks. (7) New-type, oil-fired boilers. (8) Mooring winches. (9) Crew's swimming pool. (10) Crew's quarters with individual cabins, library, cinema, gymnasium, lounge, etc. (11) Streamlined funnel. (12) Navigating bridge—engines and all machinery will also be remote-controlled from here. (13) Cargo tank hatches. (14) Fore and aft gangway above the deck. (15) Centre oil cargo tanks. (16) Wing oil cargo tank with anti-swell plate construction. (17) Oil pipe lines. (18) Keel plate which, with other plates, will be welded to the other half of the tanker. (19) Loading and discharge valves and pipelines. (20) Derricks for handling oil hose-pipes. (21) Launching ways.

## KEY TO SECOND HALF BEING BUILT

(22) Keel blocks. (23) Keel plate to be welded to the other half. (24) Wing oil cargo tank. (25) Centre oil cargo tank. (26) Wing oil cargo tank. There are eight main tanks divided into three like this—making 24 in all. (27) Two wing tanks—one each side—are used for sea-water ballast. (28) Prefabricated bow section to be welded into position.



The two halves of the tanker are brought together in a fitting-out dock. Keel plates are welded under water and all other plates are welded. Bottom of the black band is the fully-loaded water line.

The enormous size of the future tankers can be compared with four international-sized football pitches, each 120 yards long, that is 1,440 feet. The world's largest liner, the *Queen Elizabeth*, is 1,031 feet long.



In the future, fish will be bred in cages and transported to the surface. The farm will be run by divers who will live underwater and have jeeps on the sea-bed, miniature submarines and remote underwater television to keep an eye on things. Farming fish will take place on the continental shelves—that is the sea-bed extending next to the coasts of the world. We have astronauts in outer space, soon oceanauts will inhabit inner space!

**We have astronauts in outer space, soon oceanauts will inhabit inner space!**



- (1) Fish hives containing spawn. (2) Diver carrying the spawn to hatcheries. (3) Hatcheries where the fish eggs are piped into the cages. (4) Feeding machine sends synthetic food into the cages. (5) Miniature submarines with crew who can supervise all operations. (6) Lobster breeding pots. (7) Cages for crustaceans (shell fish) laid out in terraces. (8) Fish factory ship being loaded from containers. (9) Helicopter platform and control tower. (10) Gantry support on sea-bed. (11) Containers full of fish being transported to the surface. (12) Giant mirrors trap the sun's rays to promote the growth of algae fish-food in the sea. (13) Underwater atomic power-plant supplies the farm's electrical requirements. (14) Fish-feeding machine. (15) One of six cages. (16) Underwater jeep transporter. (17) Fish container being filled. (18) Fully-grown fish are extracted from the cages into the containers, and transported to the waiting ships. (19) Fertilized eggs are piped into the cages and here the fish breed and feed. (20) The cages are built on the sea-bed and covered with nylon mesh. (21) Divers' underwater living quarters. (22) Divers entering air lock. (23) Experimental fish tanks. (24) Underwater research station overlooking the farm.



# RENOWN—NEW AND OLD

## A FAMOUS NAME IN THE ROYAL NAVY

RECENTLY launched, and to be ready for sea in 1968, is the British Polaris submarine *Renown*, officially known as Nuclear Powered Ballistic Missile Submarine. A detailed comparison is shown here with the battle-cruiser *Renown*, which, after distinguished service in the last war, was scrapped in 1948. The two inset drawings (at the bottom of the page) show the striking points of difference between the fire power of the two vessels. Famous names are always carried forward in the Royal Navy, so Britain's four Polaris submarines to be built will be named *Renown*, *Repulse*, *Resolution* and *Revenge*—all after famous battleships of the past.

**Battle-Cruiser *Renown*, 32,000 tons.**  
Launched 1916. Completely reconstructed 1939. Scrapped 1948. Length, 794 ft.; speed 31½ knots; six 15-in. guns; crew, 1,205; cruising range, 3,650 miles.

The submarine *Renown* will be equipped with 16 Polaris missiles similar to the American Polaris submarines. The missiles are fired underwater at a depth of about 80 ft. while the submarine is cruising at a quiet speed of 5 knots, and can destroy a target 2,875 miles away. (The 15-in. guns of the battle-cruiser *Renown* had a range of 16 miles.) The atomic reactor of the submarine will enable her to circle the world several times without refuelling.

For security reasons, our cutaway of the Polaris submarine *Renown* is an impression based on the present atomic submarine *Dreadnought* plus the Polaris missile compartment of the American Polaris submarines.

### KEY TO NUMBERED PARTS:

(1) Crew's quarters and mess rooms. (2) Workshops, etc. (3) Stores. (4) Cordite magazines. (5) 15-in. shell magazines. (6) Ammunition hoists to gun turrets. (7) Armour belt. (8) 'A' turret—two 15-in. guns. (9) 'B' turret—two 15-in. guns. (10) Navigation bridge. (11) Main fire-control top—15-in. guns. (12) Secondary fire-control tops—4-in. guns. (13) Tripod foremast. (14) Main searchlights. (15) Multiple anti-aircraft guns. (16) Secondary armament—twelve 4-in. guns. (17) Fan rooms. (18) Four boiler rooms—eight oil-fired boilers. (19) Crew mess rooms. (20) Aircraft hangar—four aircraft. (21) Secondary fire-control tops—4.5-in. guns. (22) Mainmast. (23) Aircraft and boat crane. (24) Aircraft catapult. (25) Main fire-control top—15-in. guns. (26) Secondary armament—eight 4.5-in. guns. (27) Steam turbine engine rooms—120,000 h.p. (28) Officers' cabins. (29) Multiple anti-aircraft guns. (30) 'Y' turret—two 15-in. guns. (31) Four propellers.

The size of the *Renown*'s atomic reactor is compared with the space taken by the eight boilers of the battle-cruiser

**Fire-power of Polaris submarine *Renown*:**  
Sixteen A3 missiles, 31 ft. 3 in. long. Weight, 35,000 lb. Range, 2,875 miles. Explosive power greater than all bombs dropped during World War II.

**Fire-power of the battle-cruiser *Renown*:**  
Six 15-in. guns  
Range—16 miles

Twelve 4-in. guns  
Eight 4.5-in. guns

Weight of shell: 1,920 lb.  
Cordite charge: 428 lb.

Weight of shell: 31 lb.  
Cordite charge: 7½ lb.

**Polaris Submarine *Renown*, 7,500 tons, launched February 1967.** Length, 425 ft.; speed 25 knots submerged. Sixteen A3 Polaris missiles; six 21-in. torpedo tubes; two crews of 135, changed over every three months; cruising range, unlimited.

### KEY TO NUMBERED PARTS:

(1) Forward hydroplanes. (2) Six torpedo tubes. Radar scanner in nose. (3) Forward escape chamber. (4) Torpedo room. (5) Main ballast tanks. (6) Batteries. (7) Crew's mess room. (8) Officers' cabins and wardroom. (9) Surface navigation position. (10) Periscopes, radar and radio aerials. (11) Conning tower. (12) Ship's control room. (13) Crew's quarters. (14) Gyro-scope room. (15) Missile control room. (16) Navigation room. (17) Polaris missile being ejected from tube by compressed air. Rocket motor then takes over. (18) Missile hatches. (19) Compartment for 16 Polaris missiles. (20) Compressed-air missile ejectors. (21) Circulation pumps. (22) Heat exchangers. Steam is generated here for driving the turbines. (23) Radiation shielding. (24) Pressurized water-cooled atomic reactor. This creates enormous heat to produce steam. (25) Reactor access hatch. (26) Reactor control room. (27) Aft escape hatch. (28) Main propulsion turbines. (29) Condensers—water from exhaust steam is fed back to reactor heat exchangers. (30) Electric motor for alternative drive. (31) Steering rudders. (32) Aft hydroplanes or diving rudders. (33) Large single propeller.

Six torpedo tubes with 21-in. torpedoes.



# Sea Ranger licks the waves

## Specifications:

Hull length: 30 ft.; Cruise speed: 35-40 knots; Hull beam: 15 ft. 6 ins.; Take-off speed: 20 knots; Draft - foils down: 8 ft. 4 ins. Speed - foils retracted: 10 knots; Draft - foils retracted: 1 ft. 7 ins.; Displacement: 7½ tons; Disposal load: 5,400 lb.

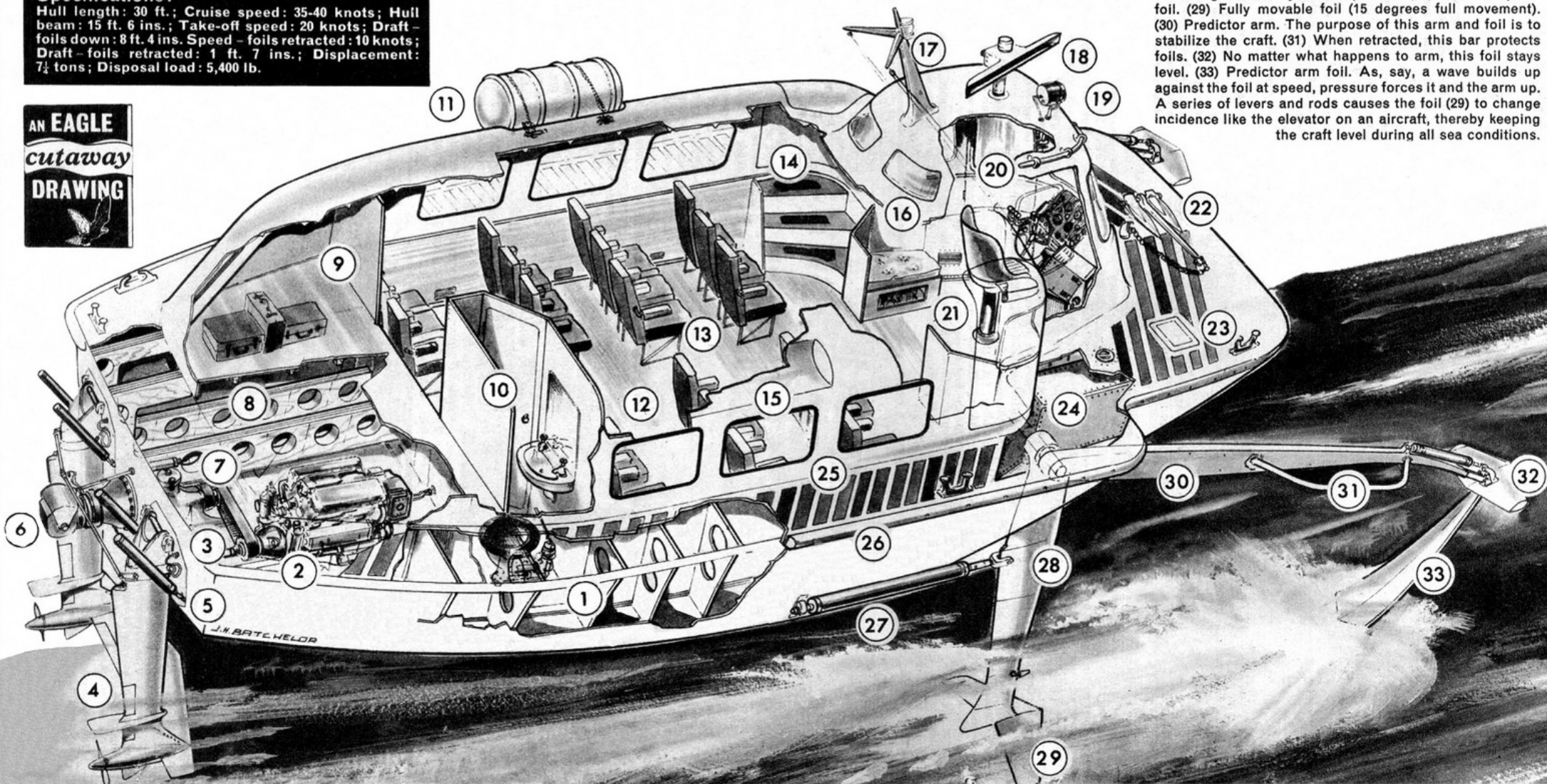


**T**HERE will always be differences of opinion as to which vessel - the hydrofoil or the A.C.V. (air cushion vehicle - hovercraft) - can provide the most efficient service at an economical cost.

Where very shallow waters are part of a route, or beaching is required, the hovercraft is, without doubt, on its own. However, if a known depth of water is to be traversed - say between Southampton and Cowes in the Isle of Wight, where there are piers and a consistent depth of at least 10 feet of water - the hydrofoil is superior.

Because its forward speed lifts it out of the water, the hydrofoil does not have to waste enormous amounts of power getting 'air/foible'. *Sea Ranger*, now being built in the Isle of Wight for the designers, Southern Hydrofoils Ltd., has high speed and high cruising water-clearance on fully submerged hydrofoils. Along with its automatic stabilizers, this makes it a very practical craft for operation in comfort in up to 8-foot-high waves.

(1) Fibreglass construction on production models. (2) Engines: Two Detroit Diesel (General Motors) 6V-53N, 216 h.p. 6 cylinder Diesels (one only shown). (3) Toothed belt takes power from pulley to jet unit (see 6 and 7). (4) Outdrives for powering craft connected by aft hydrofoil. Between the outdrives there is a trailing edge flap on the foil, and rudders are on the outdrives themselves. (5) Four hydraulic rams retract the outdrives and foil backwards, well clear of the water and possible damage. (6) Dowty water jet unit. Water is picked up from underside of craft and blown at high speed out of the rear end. This is used when foils and, therefore, propellers are retracted. (7) Power from engines drives water-jet turbine. (8) Engines bolted to these enormous bearers which form main part of structural strength. (9) Engine-room top forms luggage compartment. (10) Toilet. (11) Self-inflating life raft. (12) Air-conditioned saloon. (13) Seats for 21 passengers. (14) Port and starboard: entrance door and steps. (15) Indent in roof to take life raft. (16) Good all-round view for pilot in raised cockpit. (17) Signal mast. (18) Radar. (19) Signal lamp. (20) Emergency door. (21) Pilot's seat and controls. (22) Anchor. (23) Hatch to deck for stowage. (24) Fuel tanks (60 gallons either side). (25) Non-slip pads on deck. (26) Heavy rubber fender. (27) Hydraulic ram for retracting forward hydrofoil upwards. (28) Forward hydrofoil. (29) Fully movable foil (15 degrees full movement). (30) Predictor arm. The purpose of this arm and foil is to stabilize the craft. (31) When retracted, this bar protects foils. (32) No matter what happens to arm, this foil stays level. (33) Predictor arm foil. As, say, a wave builds up against the foil at speed, pressure forces it and the arm up. A series of levers and rods causes the foil (29) to change incidence like the elevator on an aircraft, thereby keeping the craft level during all sea conditions.





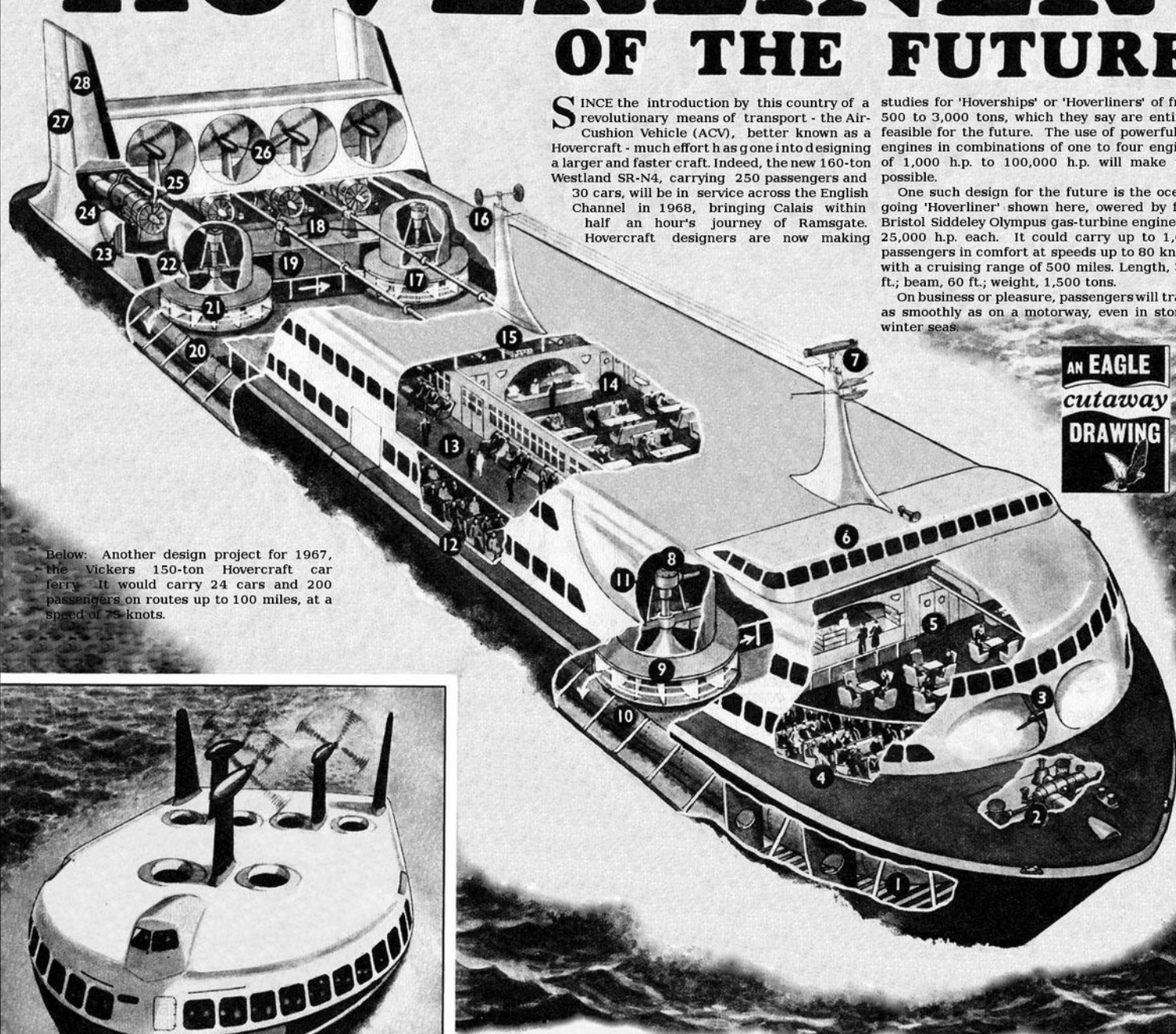
# 'HOVERLINER' OF THE FUTURE

SINCE the introduction by this country of a revolutionary means of transport - the Air-Cushion Vehicle (ACV), better known as a Hovercraft - much effort has gone into designing a larger and faster craft. Indeed, the new 160-ton Westland SR-N4, carrying 250 passengers and 30 cars, will be in service across the English Channel in 1968, bringing Calais within half an hour's journey of Ramsgate. Hovercraft designers are now making

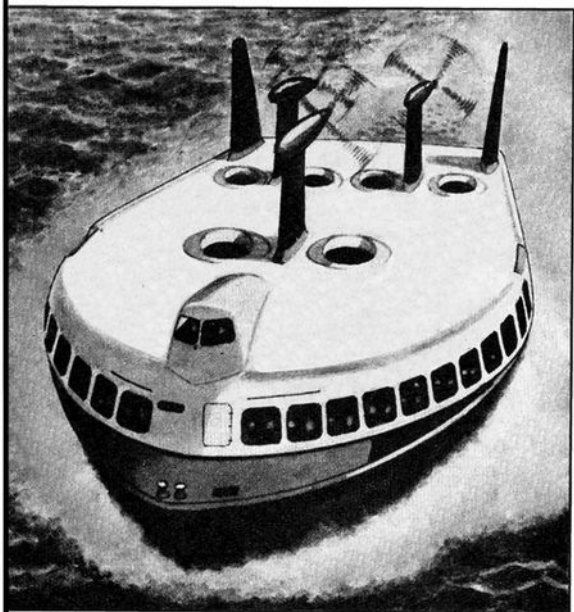
studies for 'Hoverships' or 'Hoverliners' of from 500 to 3,000 tons, which they say are entirely feasible for the future. The use of powerful jet engines in combinations of one to four engines of 1,000 h.p. to 100,000 h.p. will make this possible.

One such design for the future is the ocean-going 'Hoverliner' shown here, powered by four Bristol Siddeley Olympus gas-turbine engines of 25,000 h.p. each. It could carry up to 1,000 passengers in comfort at speeds up to 80 knots, with a cruising range of 500 miles. Length, 300 ft.; beam, 60 ft.; weight, 1,500 tons.

On business or pleasure, passengers will travel as smoothly as on a motorway, even in stormy winter seas.



Below: Another design project for 1967, the Vickers 150-ton Hovercraft car ferry. It would carry 24 cars and 200 passengers on routes up to 100 miles, at a speed of 75 knots.

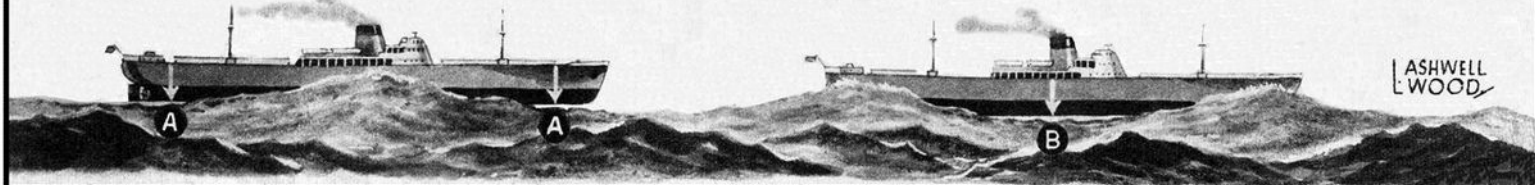


## KEY

(1) Strengthened bows for wave impact. (2) Small gas-turbine engine for sideways thrust fan - also drives mooring capstans. (3) Forward fan giving port or starboard sideways thrust for control in harbours, etc. (4) Lower passenger deck. (5) Observation lounge and cafeteria. (6) Navigation bridge - radar and radio rooms. (7) Radar scanner. (8) Fan drive gearbox. (9) Forward starboard lift fan. (10) Lift air ducts and buoyancy chamber. (11) Fan air intake. (12) Lower passenger deck. (13) Promenade deck. (14) First-class lounge. (15) Engine

controls and forward fan drive shafts. (16) Radio direction aeriels. (17) Aft port lift fan. (18) Forward fan drive shafts. (19) Fuel tanks. (20) Lift air ducts and buoyancy chamber. (21) Aft starboard lift fan. (22) Fan air intake. (23) Engine air intake. (24) One of four Bristol Siddeley Marine Olympus gas-turbine engines of 25,000 h.p. each, with overhead drive to propulsion propellers and lift fans. (25) Gearbox for both drives. (26) Four forward propulsion propellers. (27) Anti-icing strip. (28) Stability rudders.

The strains on a conventional ship in heavy seas are very great. One such condition, known as 'Hogging', leaves the ship unsupported at each end (A-A). Another condition, 'Sagging', leaves the ship unsupported amidships (B). With future large Hovercraft these conditions will not exist, as the craft will be supported all the time by the air cushion.



ASHWELL & WOOD



# THE FASTEST FIGHTER AFLOAT!

## KEY TO NUMBERED PARTS

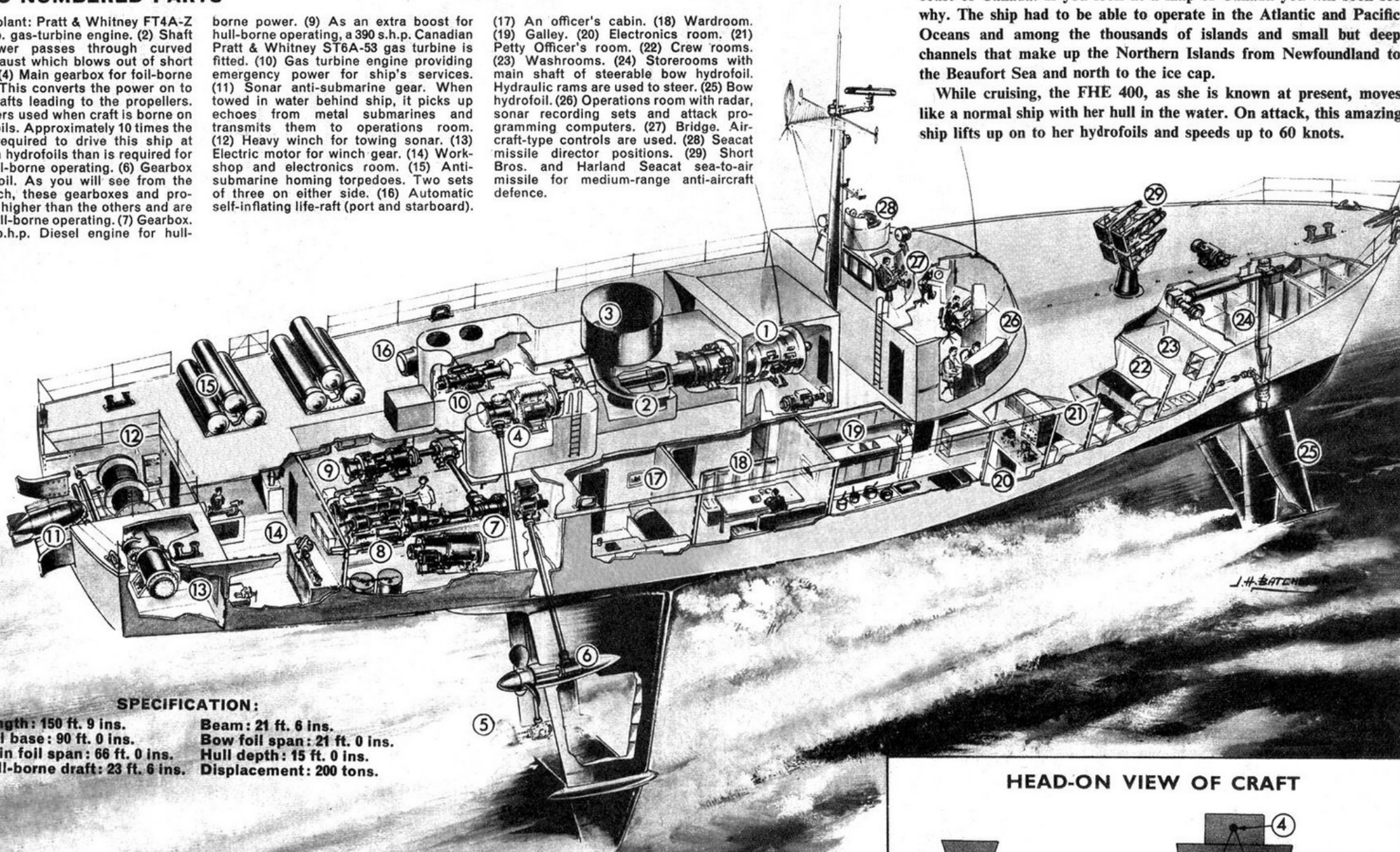
(1) Power plant: Pratt & Whitney FT4A-Z 22,000 s.h.p. gas-turbine engine. (2) Shaft taking power passes through curved engine exhaust which blows out of short funnel (3). (4) Main gearbox for foil-borne operating. This converts the power on to the two shafts leading to the propellers. (5) Propellers used when craft is borne on the hydrofoils. Approximately 10 times the power is required to drive this ship at 60 knots on hydrofoils than is required for 25-knot hull-borne operating. (6) Gearbox on outer foil. As you will see from the small sketch, these gearboxes and propellers are higher than the others and are used for hull-borne operating. (7) Gearbox. (8) 2,000 b.h.p. Diesel engine for hull-

borne power. (9) As an extra boost for hull-borne operating, a 390 s.h.p. Canadian Pratt & Whitney ST6A-53 gas turbine is fitted. (10) Gas turbine engine providing emergency power for ship's services. (11) Sonar anti-submarine gear. When towed in water behind ship, it picks up echoes from metal submarines and transmits them to operations room. (12) Heavy winch for towing sonar. (13) Electric motor for winch gear. (14) Workshop and electronics room. (15) Anti-submarine homing torpedoes. Two sets of three on either side. (16) Automatic self-inflating life-raft (port and starboard).

(17) An officer's cabin. (18) Wardroom. (19) Galley. (20) Electronics room. (21) Petty Officer's room. (22) Crew rooms. (23) Washrooms. (24) Storerooms with main shaft of steerable bow hydrofoil. Hydraulic rams are used to steer. (25) Bow hydrofoil. (26) Operations room with radar, sonar recording sets and attack programming computers. (27) Bridge. Aircraft-type controls are used. (28) Seacat missile director positions. (29) Short Bros. and Harland Seacat sea-to-air missile for medium-range anti-aircraft defence.

It was the National Research Establishment of the Canadian Defence Ministry that decided that a foil-borne ship of approximately 200 tons was the best type for anti-submarine work off the coast of Canada. If you look at a map of Canada you will soon see why. The ship had to be able to operate in the Atlantic and Pacific Oceans and among the thousands of islands and small but deep channels that make up the Northern Islands from Newfoundland to the Beaufort Sea and north to the ice cap.

While cruising, the FHE 400, as she is known at present, moves like a normal ship with her hull in the water. On attack, this amazing ship lifts up on to her hydrofoils and speeds up to 60 knots.



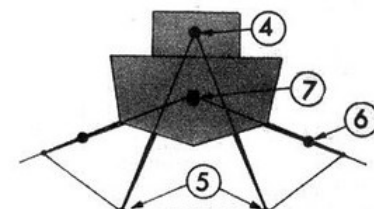
## SPECIFICATION:

|                                 |                              |
|---------------------------------|------------------------------|
| Length: 150 ft. 9 ins.          | Beam: 21 ft. 6 ins.          |
| Foil base: 90 ft. 0 ins.        | Bow foil span: 21 ft. 0 ins. |
| Main foil span: 66 ft. 0 ins.   | Hull depth: 15 ft. 0 ins.    |
| Hull-borne draft: 23 ft. 6 ins. | Displacement: 200 tons.      |

## HEAD-ON VIEW OF CRAFT



BOW HYDROFOIL



AFT HYDROFOIL

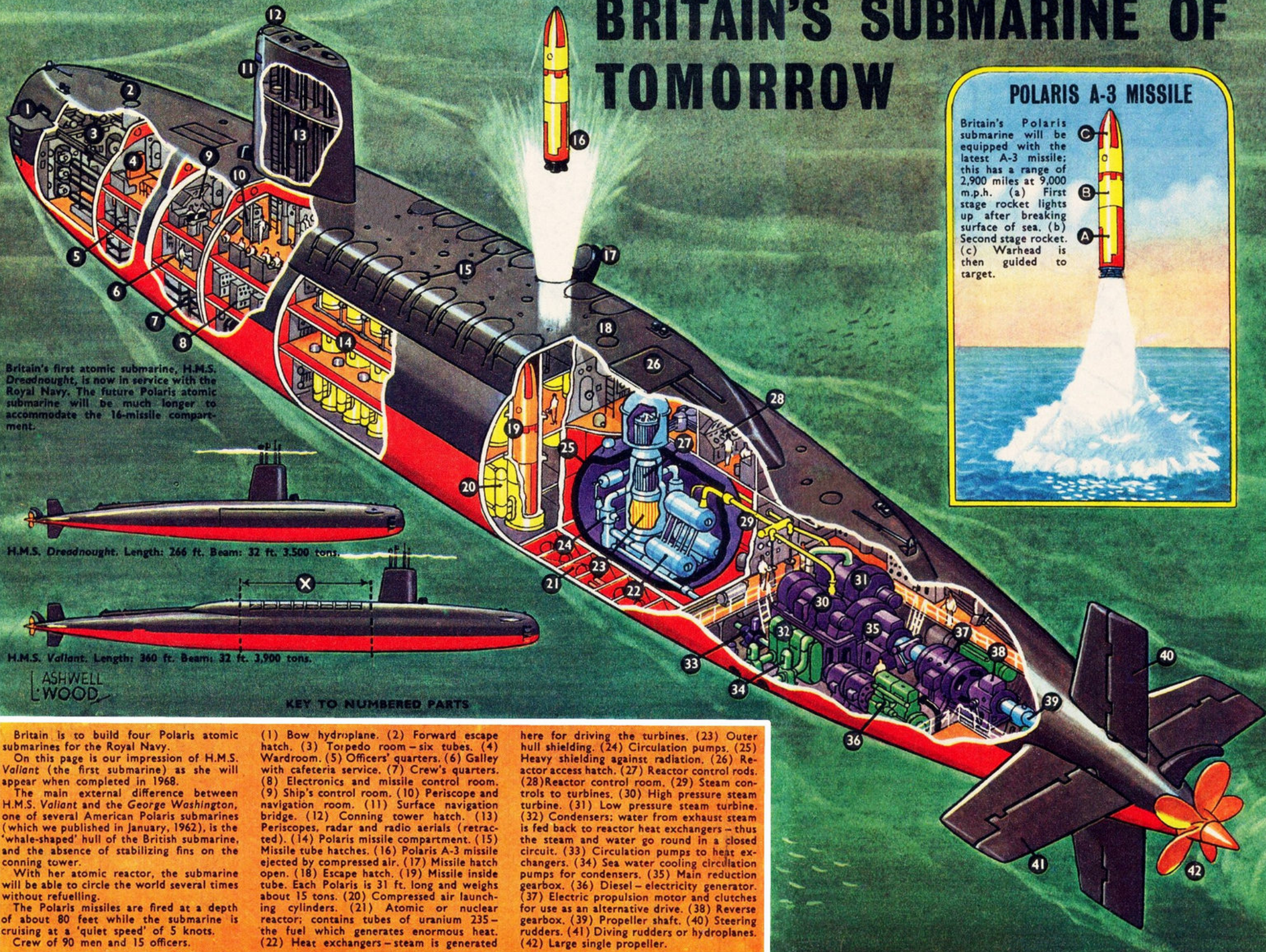
The numbers shown here correspond to the numbers in the main diagram above.



# BRITAIN'S SUBMARINE OF TOMORROW

## POLARIS A-3 MISSILE

Britain's Polaris submarine will be equipped with the latest A-3 missile; this has a range of 2,900 miles at 9,000 m.p.h. (a) First stage rocket lights up after breaking surface of sea. (b) Second stage rocket. (c) Warhead is then guided to target.



Britain's first atomic submarine, H.M.S. Dreadnought, is now in service with the Royal Navy. The future Polaris atomic submarine will be much longer to accommodate the 16-missile compartment.

H.M.S. Dreadnought. Length: 266 ft. Beam: 32 ft. 3,500 tons.

H.M.S. Valiant. Length: 360 ft. Beam: 32 ft. 3,900 tons.

ASHWELL  
WOOD

### KEY TO NUMBERED PARTS

Britain is to build four Polaris atomic submarines for the Royal Navy.

On this page is our impression of H.M.S. Valiant (the first submarine) as she will appear when completed in 1968.

The main external difference between H.M.S. Valiant and the George Washington, one of several American Polaris submarines (which we published in January, 1962), is the 'whale-shaped' hull of the British submarine, and the absence of stabilizing fins on the conning tower.

With her atomic reactor, the submarine will be able to circle the world several times without refuelling.

The Polaris missiles are fired at a depth of about 80 feet while the submarine is cruising at a 'quiet speed' of 5 knots.

Crew of 90 men and 15 officers.

(1) Bow hydroplane. (2) Forward escape hatch. (3) Torpedo room—six tubes. (4) Wardroom. (5) Officers' quarters. (6) Galley with cafeteria service. (7) Crew's quarters. (8) Electronics and missile control room. (9) Ship's control room. (10) Periscope and navigation room. (11) Surface navigation bridge. (12) Conning tower hatch. (13) Periscopes, radar and radio aerials (retracted). (14) Polaris missile control room. (15) Missile tube hatches. (16) Polaris A-3 missile ejected by compressed air. (17) Missile hatch open. (18) Escape hatch. (19) Missile inside tube. Each Polaris is 31 ft. long and weighs about 15 tons. (20) Compressed air launching cylinders. (21) Atomic or nuclear reactor; contains tubes of uranium 235—the fuel which generates enormous heat. (22) Heat exchangers—steam is generated

here for driving the turbines. (23) Outer hull shielding. (24) Circulation pumps. (25) Heavy shielding against radiation. (26) Reactor access hatch. (27) Reactor control rods. (28) Reactor control room. (29) Steam controls to turbines. (30) High pressure steam turbine. (31) Low pressure steam turbine. (32) Condensers; water from exhaust steam is fed back to reactor heat exchangers—thus the steam and water go round in a closed circuit. (33) Circulation pumps to heat exchangers. (34) Sea water cooling circulation pumps for condensers. (35) Main reduction gearbox. (36) Diesel—electricity generator. (37) Electric propulsion motor and clutches for use as an alternative drive. (38) Reverse gearbox. (39) Propeller shaft. (40) Steering rudders. (41) Diving rudders or hydroplanes. (42) Large single propeller.



# HOVER TRAINS OF TOMORROW

**B**ECAUSE they ride on air instead of wheels, the possibilities of the cushion-trains of the future are very great; friction and weight are reduced, vibration is less, and speed increased.

They would give a boost to British transport, and officials of British Rail are to study the experiments now going on.

One such project shown here is the Ford Levacar, designed to ride on a thin cushion of air over the simple concrete tracks. Two 100 h.p. engines driving centrifugal fans will provide the lift and a jet engine driving a propeller will give forward speed. With 120 passengers, the train could travel at 100 m.p.h. for urban district work or between airports and city centres, and up to 300 m.p.h. on long stretches between cities.

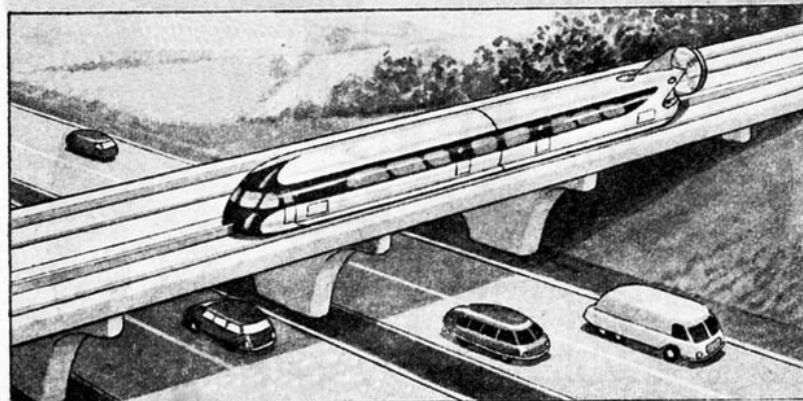
A fast freight carrier which can be separated for loading specially designed containers would speed up the freight services between cities.

Other designs are being studied for a 300 m.p.h. hovertrain by the Hovercraft Development Ltd. technical group, and in France an experimental Aerotrain is undergoing tests on a concrete track.

## KEY TO NUMBERED PARTS

(1) Driver's compartment and engine controls. (2) 100 h.p. engine driving the forward fans. (3) Centrifugal fans supplying air for the lift or air cushion. (4) Path of lift air under the train. (5) Retractable weight-carrying wheels when train is stationary. (6) Path of lift air for the forward half of the train. (7) Forward passenger saloon—64 seats. (8) Flexible joint for curved track. (9) Air-operated sliding doors. (10) Rear passenger saloon—64 seats. (11) Sound-proof partition. (12) 100 h.p. engine driving the rear fans. (13) Air inlet ducts. (14) Centrifugal fans supplying air for the lift. (15) Path of lift air for the rear half of the train. (16) Air inlet to jet engine. (17) Jet engine driving the propulsion propeller. (18) Reduction gearing. (19) Propeller guard. (20) Four-bladed propulsion propeller, with reversible pitch, giving the train its forward speed. (21) Jet exhaust. (22) Fan engine exhaust. (23) Track guide vane. (24) Concrete track. (25) Separation joint; this allows the specially designed container to be loaded. (26) Freight containers. (27) Retractable weight-carrying wheels, lowered. (28) Retractable loading platform extended from freight depot. (29) Container lift truck. (30) Special freight container being filled.

AN EAGLE  
cutaway  
DRAWING



Because the air-lift takes the weight of the 'cushion-train', lightweight concrete tracks could be built flat on the ground and pass over motorways, or even run above and along them. The same could apply to existing railways.

LASHWELL  
WOOD



# THE FLYING SAUCERS OF TODAY AND TOMORROW

"Do you believe in flying saucers?" That question has been debated for years - and still nobody knows the truth of the matter. Books have been written about them, science fiction writers have flown us to Mars in them, authorities say they don't exist - and people go on seeing them. Perhaps, one day, a spaceship from outer space really will land on Earth and put an end to all speculation. Until then, well, there's no harm in wondering about this strange mystery of the skies . . .

WHEN it comes to inventions, the Dan Dare team of writers and artists have always been way ahead of the field. Many of the 'impossible' machines, craft and weapons which have appeared in EAGLE in the past have later become realities. In his new book - 'Piece for a Jigsaw' - Leonard Cramp says: "Regardless of the magnitude of the ship's acceleration, the crew would experience the gravitational environment of their home planet, while alternative 'g' arrangements could be made for any different beings they were transporting. It is interesting to note that these and other similar inclusions have been made by the authors of the famous Dan Dare series!"



'Piece for a Jig-Saw' is a book about flying saucers. Many books on flying saucers have appeared in recent years, and Leonard Cramp, a qualified engineer, brings the research right up to date by examining

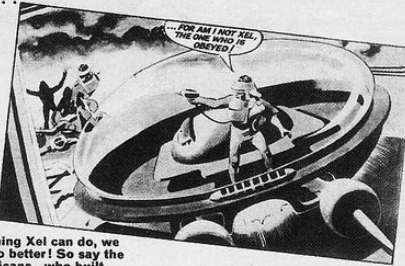
Mr Cramp's machine exists only in theory, but two other scientists, one in Australia and one in America, have recently designed flying machines on the classical saucer pattern. Both hope to prove that the disc shape is a practical one for travelling the sky. A model saucer built by the Austra-



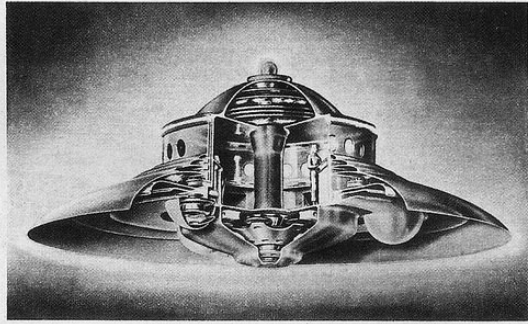
This strange object was photographed in Ireland. "It was like a large silver bullet, with a bright flame-like plume behind it . . ."

lian, who wishes to remain anonymous, has recently been successfully tested in Canberra. The actual machine, he says, will fly with the aid of jet motors which will make the outer rim of the saucer rotate at high speed. The problem of keeping the cabin, situated in the 'hub' of the craft, from revolving also, has been solved with 'neutralizing motors' says the inventor. But he is keeping the details secret. Professor Paul Moller, of California University, who is building the other flying saucer, is equally cautious about revealing details of his craft. All he will say is that it has been designed to take off vertically and fly at 100 m.p.h. on four engines. Both men think of their saucers as family flying cars of the future. Professor Moller calculates that his

various sightings on a purely technical basis. He gives his reasons why, for example, saucers should hover and stop instantly; why they are silent; and why they move through the atmosphere at high velocity without heating up. The author also advances a theory of how spaceships could be propelled by means other than the rocket. He discusses the possibility of completely converting mass into energy, thereby creating gravitational fields. He also reveals that in such a vehicle man could travel to the moon and back in under an hour - without suffering any accelerating or decelerating forces whatsoever.



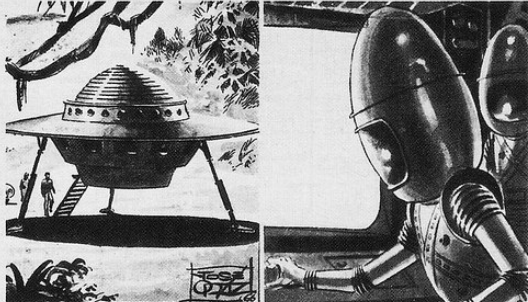
Anything Xel can do, we can do better! So say the Americans - who built this saucer-shaped craft recently



Artist's impression of the workings of a saucer. Who knows - we might feature an accurate cutaway drawing in the future!

model could be mass-produced for about £1,000. The existence of flying saucers - Unidentified Flying Objects, as they are technically called - has been tantalizing us for nearly 20 years and still nobody knows the truth about them. Hundreds of U.F.O.s. have been seen. One of the latest 'authentic' sightings has been reported by two young women who saw an object while motoring in Ireland - and photographed it! One of the women, Miss Jacqueline Wingfield, an official of the Victoria and Albert Museum, said: "It was like a large silver bullet, with a bright flame-

like plume behind it. It was moving quite slowly. What struck me most was that it made no noise." When the roll of film was handed to her colleague, Mr Charles Gibbs-Smith, the aviation historian, he said: "I have seen scores of saucer photos, but this is the first in which I can guarantee the integrity of everybody concerned. 'The object could not have been a meteorite or fireball. These things don't travel horizontally. I don't see what else it could have been but some kind of interplanetary flying machine.' To account for the silence of the strange object, Mr Gibbs-Smith said that the 'saucer' might have been powered by some kind of anti-gravity motor not understood by scientists. What flying saucers really are, where they come from, and who mans them remains one of the greatest mysteries of modern times. Except, that is, to EAGLE readers! Thanks to Major Grant and 'Boffin' Bailey, the U.F.O. agents, you know more than most people about Unidentified Flying Objects and the Zetans who brought them to earth. Once again, EAGLE is way ahead of the field. \* 'Piece for a Jig-Saw' is published at 12s. 6d. by Somerton Publishers Ltd., Newport Road, West Cowes, Isle of Wight.

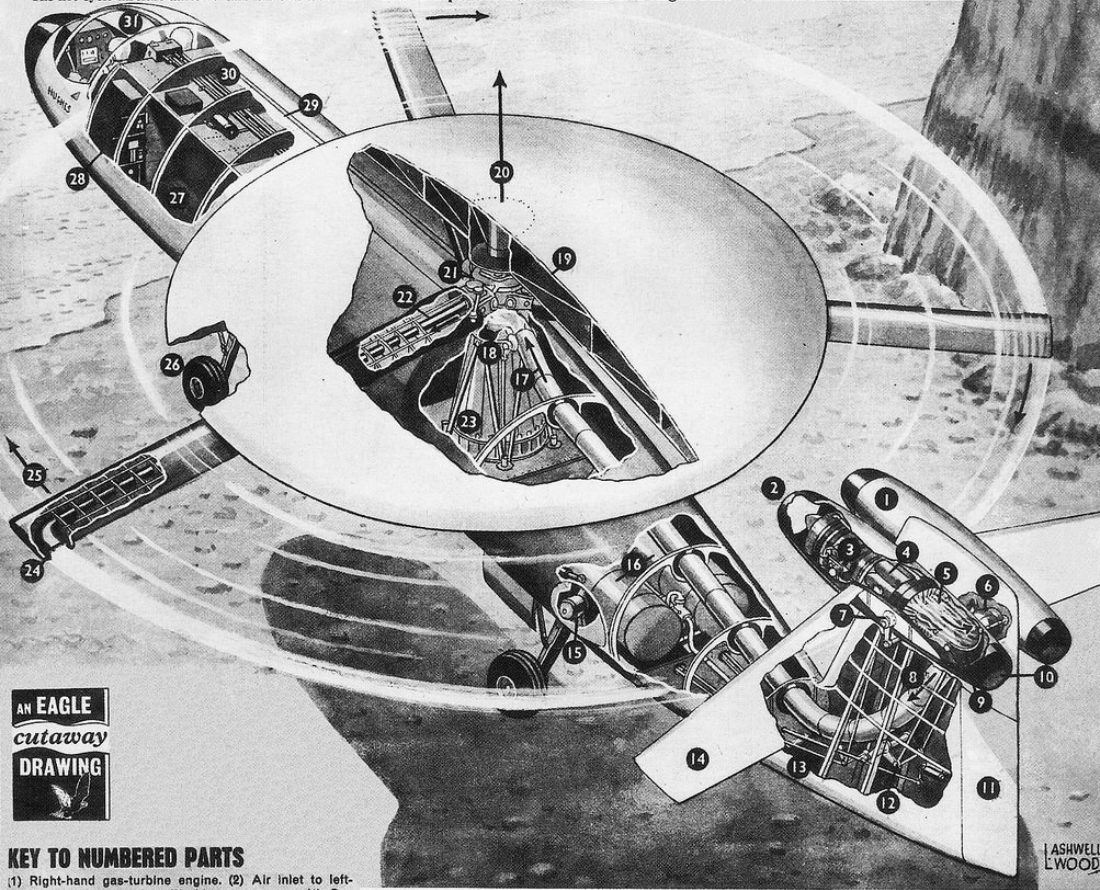


This flying saucer and the friendly Zetan spaceman on the right are well known to followers of U.F.O. Agent

THIS new design for a helicopter combined with a conventional aircraft gives the impression of a real flying saucer. To be built for the U.S. Army, it is called the Hughes Hot-cycle Rotor Research Aircraft. The 'hot-cycle' part of the name comes from the rotor blade 'tip-jet' propulsion by full use of gas-turbine engine exhaust, diverted through helicopter rotors. This is distinct from the 'cold cycle' tip-jet propulsion using compressed air, as used on some helicopters. The hot-cycle aircraft takes off and lands as a normal

helicopter. At about 100 m.p.h. the hot-cycle gas is diverted from the rotor blades by means of valves, and the gas-turbine engine at the tail gives direct forward propulsion. The rotor blades are brought to rest with one blade facing forward. The large circular structure, which gives the appearance of a saucer, acts as a lifting hub to the rotor blades. When they are stopped the streamlined hub acts as an aerofoil for fixed wing, forward flight. As a result of this, the aircraft has high efficiency, both as a helicopter and as a conventional fixed-wing aircraft.

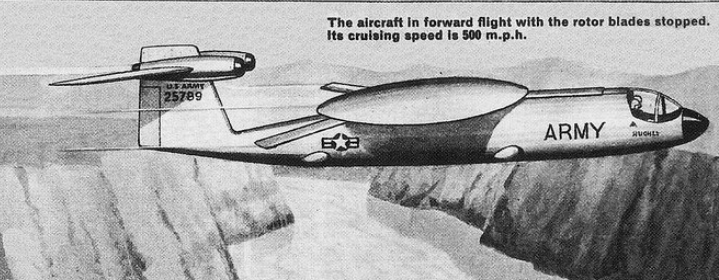
DIMENSIONS . . . Diameter of Rotor: 47 ft. Fuselage length: 73 ft. Height from ground: 20 ft.



AN EAGLE cutaway DRAWING

## KEY TO NUMBERED PARTS

- (1) Right-hand gas-turbine engine. (2) Air inlet to left-hand gas-turbine engine. (3) Air compressors. (4) Gas producers. (5) Hot exhaust gases passing to control valves. (6) Control valves for gases to rotor head. (7) Pivot for movable tail planes. (8) Gas pipe to rotor head. (9) Gas diversion valve. (10) Exhaust outlets when engines are used for forward propulsion. (11) Rudder. (12) Gas valve controls. (13) Engine controls. (14) Swept tail planes - these act as elevators and ailerons. (15) Rear retractable undercarriage. (16) Fuel tanks. (17) Gas pipe to rotor head. (18) Hot-cycle gases being distributed to each of the three rotor blades. (19) Lightweight saucer structure acts as a lifting hub to the rotor blades when used as a helicopter, and as a fixed wing for forward flight. (20) Vertical lift as a helicopter. (21) Rotor head. (22) Gas pipe to rotor blade tip. (23) Rotor support pylon. (24) Hot-cycle tip-jet propulsion for each rotor blade. (25) Direction of rotation of rotor blades driven by the tip-jet reaction of the hot gases. (26) Forward retractable undercarriage. (27) Freight bed. (28) Radio racks. (29) Recess for forward rotor blade when stopped. (30) Rotor blade pitch controls. (31) Pilot and



The aircraft in forward flight with the rotor blades stopped. Its cruising speed is 500 m.p.h.



**A** NUMBER of armed and armoured helicopters are going into service with the United States Army. Called *Chinooks* (after an Indian tribe), these helicopters will be protected by more than a ton of special steel armour along the sides and underneath against ground fire attack. Their role will be to suppress ground fire attack where ordinary troop-carrying helicopters are landing.

The *Chinook* will have a 50 mm. automatic grenade thrower mounted in the nose. Pylons on each side will carry forward-firing rockets and five gunners in the cabin will guard against flank attacks with 0.5-in. machine-guns; one gun will be mounted to fire rearwards.

Two externally mounted jet engines will drive the two 3-bladed rotors which rotate in opposite directions and are connected by a shaft along the top of the fuselage with clutch and gearboxes to enable one engine to drive both rotors if required.

Rotor blades are 59 ft. in diameter. Fuselage length is 51 ft. Top speed, 152 knots.

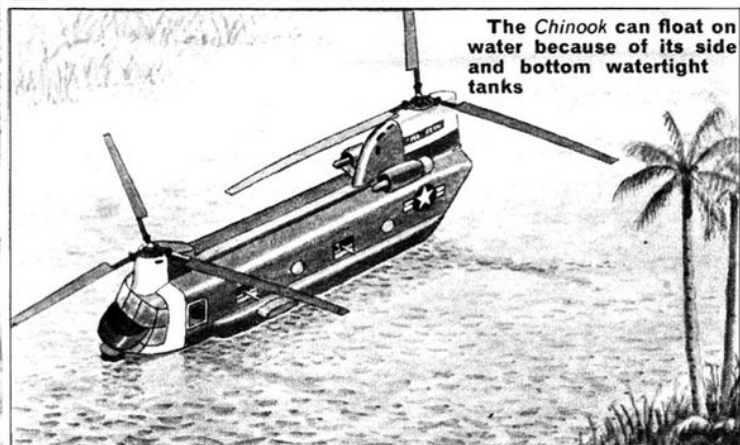
# ARMED TO THE TEETH

## KEY TO NUMBERED PARTS

(1) Rear rotor blades and direction of rotation. (2) Rotor head. (3) Rotor gearbox. (4) Auxiliary power unit for engine-starting and other functions. (5) Rearward-firing 0.5-in. machine-gun mounted over the rear loading ramp. (6) Port side Lycoming turbojet engine, 2,500 shaft horsepower. (7) Engine drive to rotor drive shafts. (8) Drive shaft to rear rotor. (9) Shaft gearbox. (10) Starboard side Lycoming engine. (11) Control runs and drive shaft to front rotor. (12) 0.5-in. machine-gun. (13) Side armour. (14) 0.5-in. machine-gun. (15) Fuel tanks and watertight compartments for buoyancy when alighting on water. These tanks and the helicopter belly are armoured

against ground fire attack. (16) Rocket pod with 19 rotating 2.75-in. rockets. (17) 0.5-in. machine-gun. (18) Ammunition boxes. (19) Control runs from pilot's cockpit and drive shaft to front rotor. (20) Front rotor blades and direction of rotation. (21) Rotor head. (22) Rotor gearbox. (23) Side door. (24) 2.75-in. rocket. (25) Radio racks. (26) Pilot and co-pilot. (27) Cyclic pitch lever. This controls the tilt of the rotor heads for forward or sideways flight. (28) Collective pitch lever. This controls the pitch of the rotor blades for vertical flight. (29) Front armour. (30) Grenade-thrower—forward on either side. Controlled by the co-pilot.

AN EAGLE  
cutaway  
DRAWING



ASHWELL  
WOOD



# 80-KNOT SHIP OF THE FUTURE

AN EAGLE  
cutaway  
DRAWING

Although still on the drawing board, this fast trimaran, a 3-hulled passenger-cargo vessel, could well be the ship of the future.

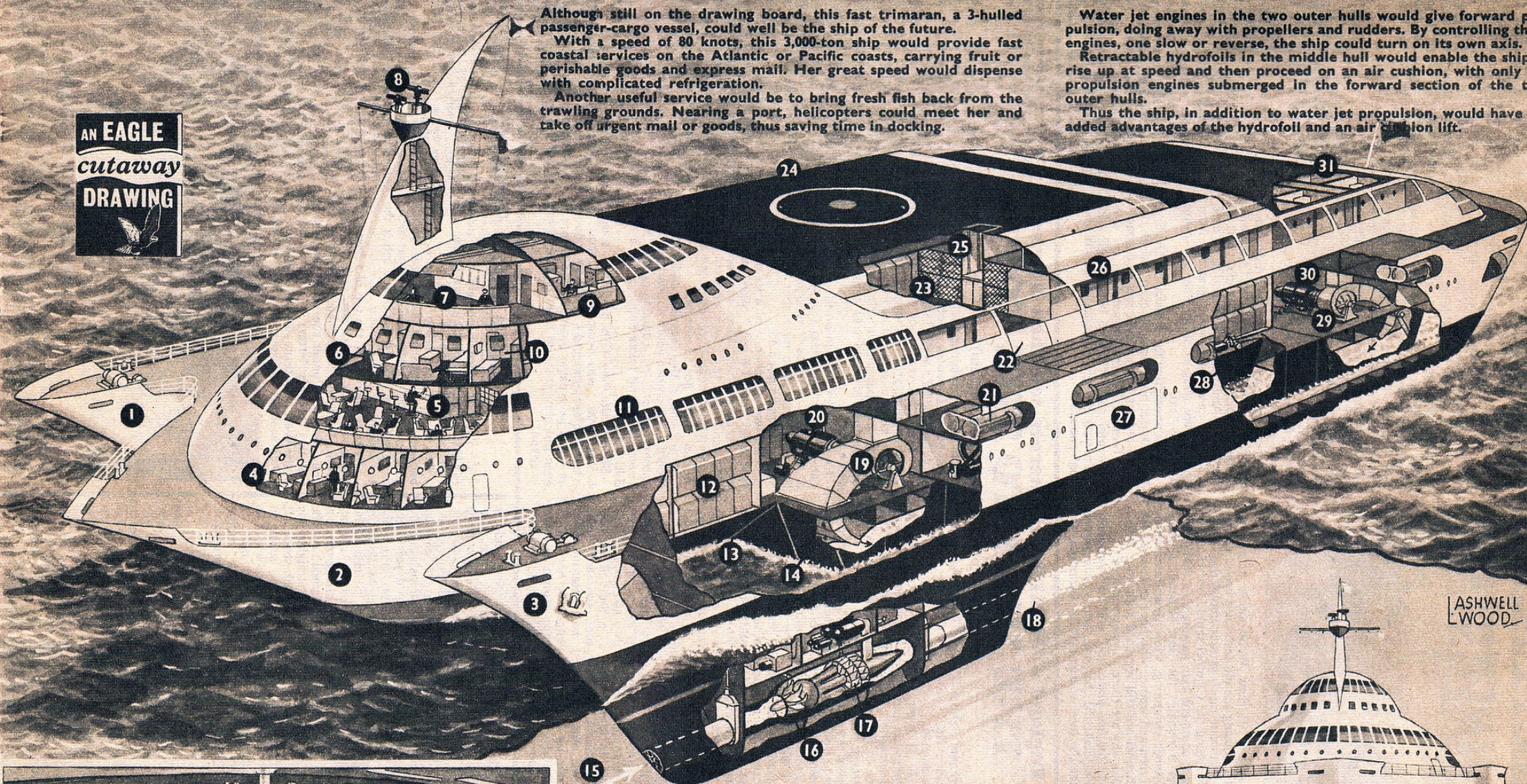
With a speed of 80 knots, this 3,000-ton ship would provide fast coastal services on the Atlantic or Pacific coasts, carrying fruit or perishable goods and express mail. Her great speed would dispense with complicated refrigeration.

Another useful service would be to bring fresh fish back from the trawling grounds. Nearing a port, helicopters could meet her and take off urgent mail or goods, thus saving time in docking.

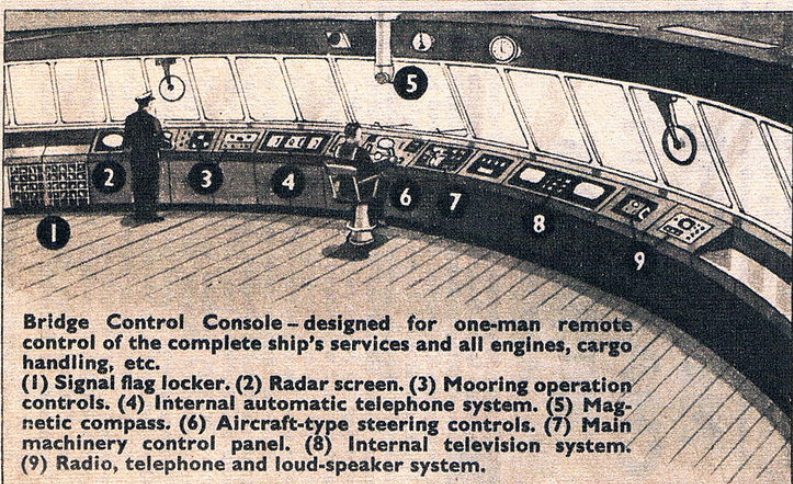
Water jet engines in the two outer hulls would give forward propulsion, doing away with propellers and rudders. By controlling these engines, one slow or reverse, the ship could turn on its own axis.

Retractable hydrofoils in the middle hull would enable the ship to rise up at speed and then proceed on an air cushion, with only the propulsion engines submerged in the forward section of the two outer hulls.

Thus the ship, in addition to water jet propulsion, would have the added advantages of the hydrofoil and an air cushion lift.

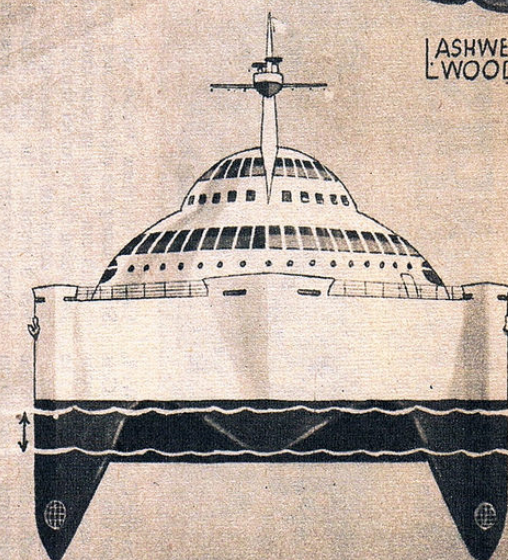


LASHWELL  
WOOD



## KEY TO NUMBERED PARTS

- (1) Starboard hull. (2) Middle hull. (3) Port hull. (4) Passenger hull.
- (5) Observation lounge. (6) Captain's day cabin. (7) Navigation bridge and control console. (8) Radar scanners. (9) Radio room. (10) Officers' cabins.
- (11) Restaurant and closed promenade. (12) Cargo hold with special loading containers. (13) Middle hull step. (14) Skirt of air cushion chamber. (15) Water entry grille. (16) Water jet engine. (17) Water propulsion turbines. (18) Water jet reaction, giving forward propulsion. (19) Lift fans for air cushion (both sides).
- (20) Fan gas turbine engine. (21) New-type life-rafts in place of conventional lifeboats. (22) Side loading deck doors for mail, cars or special containers. (23) Mail compartments. (24) Helicopter deck. (25) Deck lift.
- (26) Cabins and promenade deck. (27) Side loading doors for cargo holds. (28) Retractable hydrofoils giving initial lift when ship 'starts' forward and air cushion lift comes into operation. (29) Lift fans for air cushion (both sides).
- (30) Fan gas turbine engine. (31) Crew's quarters.



Frontal view of the trimaran ship showing the three hulls and air cushion step; the upper water level when the ship is at rest and the lower water level when she rises up at speed.

Bridge Control Console—designed for one-man remote control of the complete ship's services and all engines, cargo handling, etc.

(1) Signal flag locker. (2) Radar screen. (3) Mooring operation controls. (4) Internal automatic telephone system. (5) Magnetic compass. (6) Aircraft-type steering controls. (7) Main machinery control panel. (8) Internal television system. (9) Radio, telephone and loud-speaker system.





The 25-ton capacity Lancer side-lift-loader lifting a double-decker bus weighing 8 tons.

# WORLD'S LARGEST LIFT-LOADER

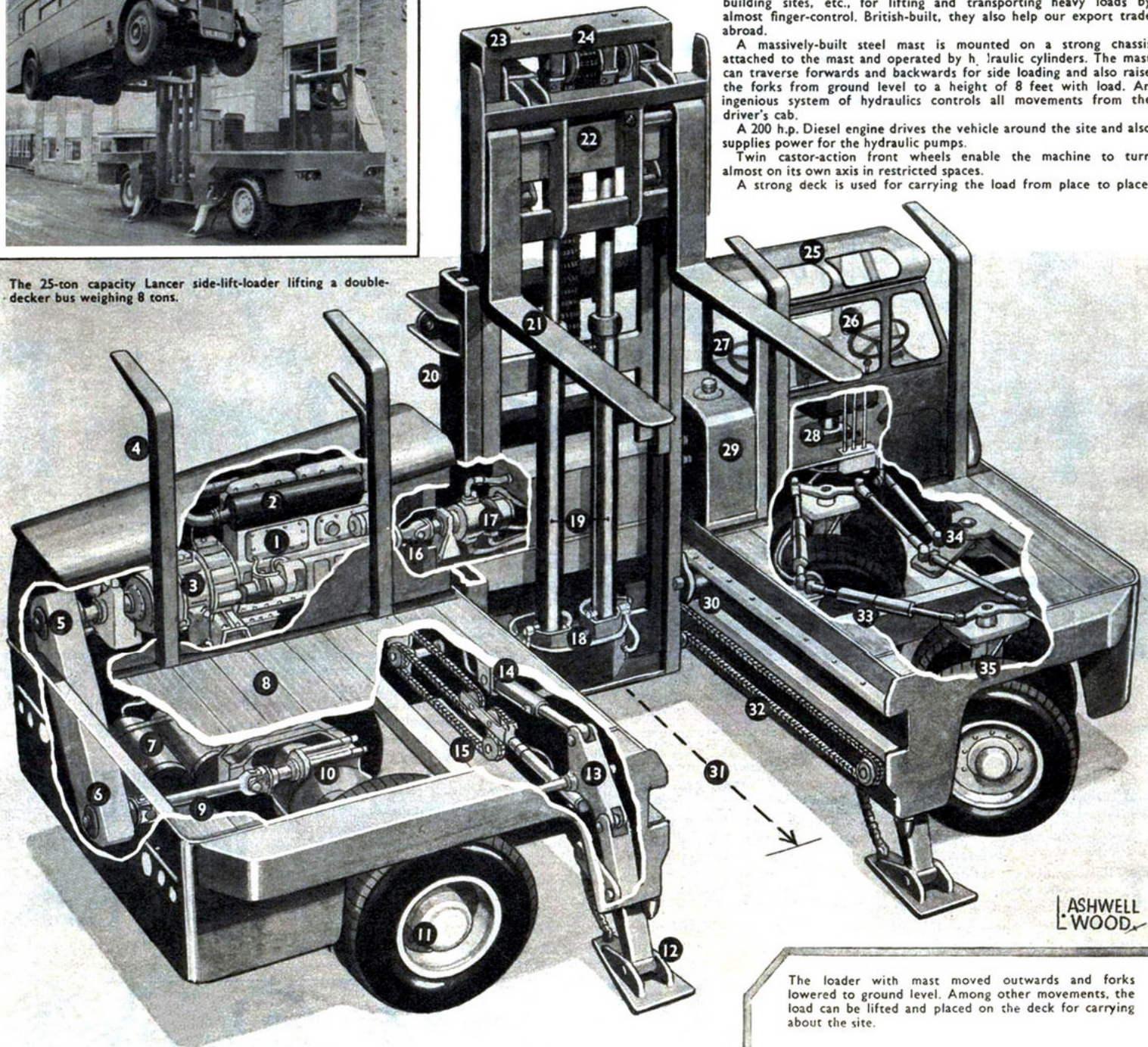
Capable of lifting 25 tons, the Lancer side-lift-loader is the largest in the world. It is used in steel works, railway yards and building sites, etc., for lifting and transporting heavy loads by almost finger-control. British-built, they also help our export trade abroad.

A massively-built steel mast is mounted on a strong chassis attached to the mast and operated by hydraulic cylinders. The mast can traverse forwards and backwards for side loading and also raise the forks from ground level to a height of 8 feet with load. An ingenious system of hydraulics controls all movements from the driver's cab.

A 200 h.p. Diesel engine drives the vehicle around the site and also supplies power for the hydraulic pumps.

Twin castor-action front wheels enable the machine to turn almost on its own axis in restricted spaces.

A strong deck is used for carrying the load from place to place.



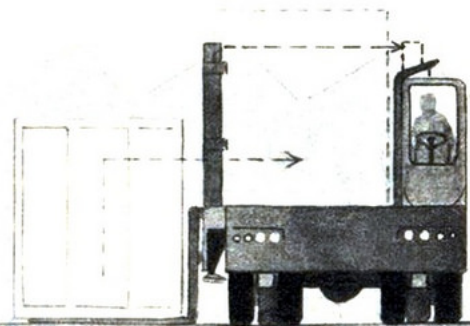
ASHWELL  
WOOD

## KEY TO NUMBERED PARTS: -

(1) 200 h.p. Leyland six-cylinder Diesel engine. (2) Exhaust silencer. (3) Fluid coupling. (4) Load protection guards. (5) Engine drive. (6) Final drive chaincase. (7) Compressed air-brake cylinders. (8) Loading deck planks. (9) Final drive shaft. (10) Overhang worm gear drive to back axle. (11) Final reduction gear in wheel hub. (12) Retractable support jacks. (13) Jack-operating arm. (14) Hydraulic jack cylinder. (15) Mast traverse chains and hydraulic cylinder. This operates the lifting mast forwards or backwards. (16) Engine drive shaft to hydraulic pumps.

(17) Pumps supplying hydraulic systems. (18) Hydraulic lift connections. (19) Lifting cylinders. (20) Main support mast. (21) Load lifting forks. (22) Lifting fork carriage. (23) Vertical sliding mast. (24) Fork lifting chain. (25) Driver's cab. (26-27) Steering wheels for forward or rearward driving positions. (28) Rotating driving seat and hydraulic controls. (29) Hydraulic fluid tank. (30) Mast traverse rollers. (31) Outward traverse of mast and lifting forks. (32) Mast traverse chains. (33) Hydraulic power steering cylinders. (34) Steering arm and track-rods for twin front wheel steering. (35) Twin front wheels mounted on castor-action pillars.

The loader with mast moved outwards and forks lowered to ground level. Among other movements, the load can be lifted and placed on the deck for carrying about the site.



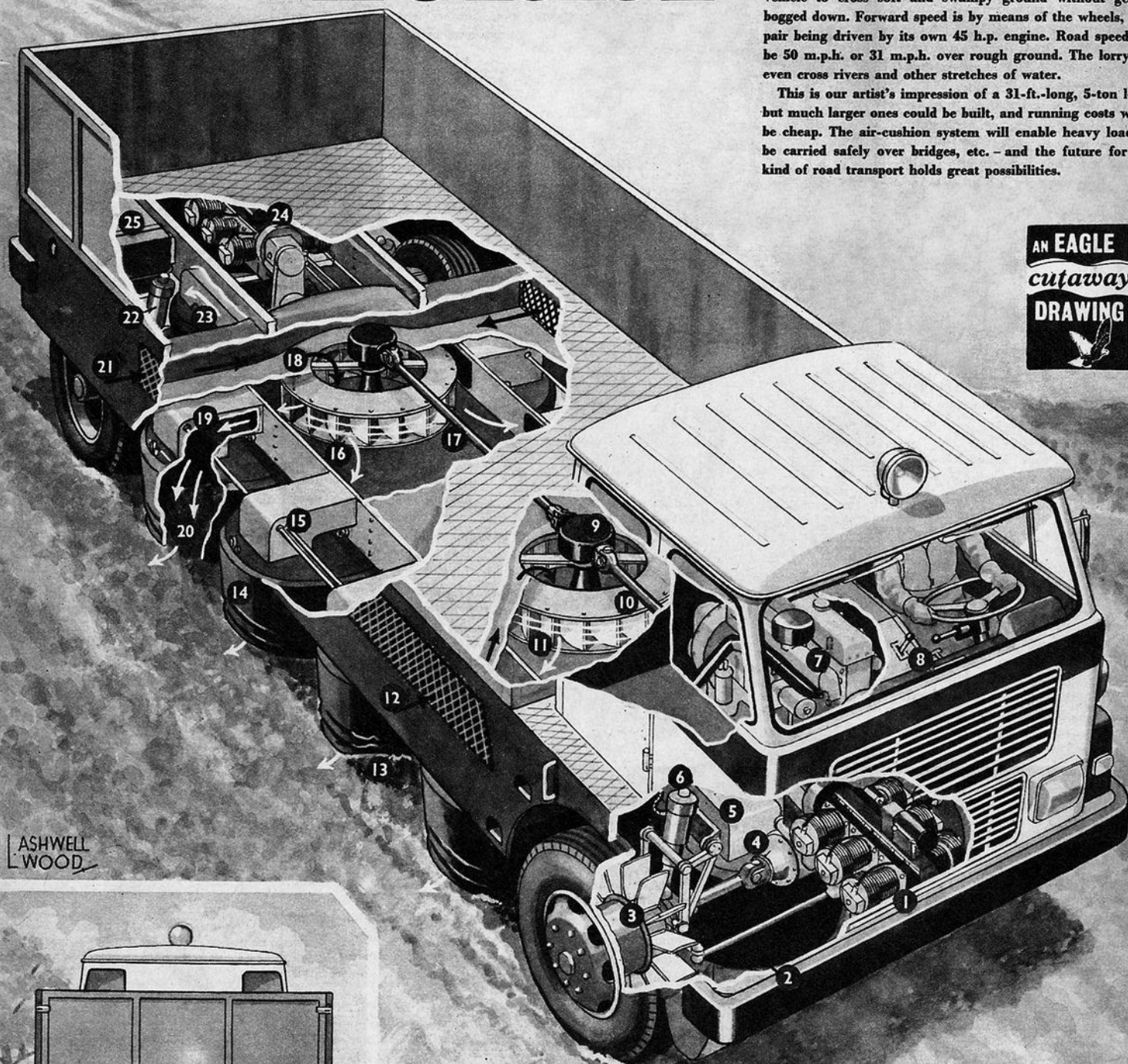
## NEXT WEEK: AIR-BUS TO THE SCILLIES!



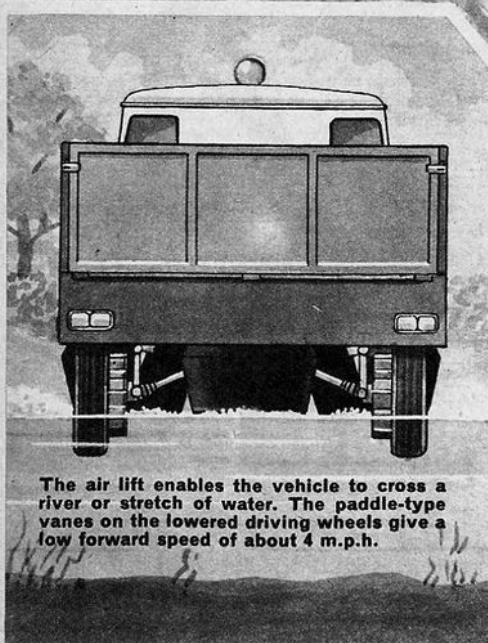
# AIR-BORNE LORRY

**D**EVELOPMENT is going ahead in France on an air-cushion vehicle for commercial transport. It works very much like an ordinary four-wheeled lorry, but it has ten flexible lift cells underneath the chassis which are supplied with air by a two-fan system driven by a 140 h.p. engine. These cells relieve the wheels of much of the weight and spread the load over a large area, thus permitting the vehicle to cross soft and swampy ground without getting bogged down. Forward speed is by means of the wheels, each pair being driven by its own 45 h.p. engine. Road speed will be 50 m.p.h. or 31 m.p.h. over rough ground. The lorry can even cross rivers and other stretches of water.

This is our artist's impression of a 31-ft.-long, 5-ton lorry, but much larger ones could be built, and running costs would be cheap. The air-cushion system will enable heavy loads to be carried safely over bridges, etc. - and the future for this kind of road transport holds great possibilities.



ASHWELL  
WOOD



The air lift enables the vehicle to cross a river or stretch of water. The paddle-type vanes on the lowered driving wheels give a low forward speed of about 4 m.p.h.

## KEY TO NUMBERED PARTS

(1) Underfloor 45 h.p. engine driving front wheels. (2) Front flexible air lift cell. (3) Extendable paddle-wheel type vanes on wheel hubs for forward propulsion through water. (4) Front wheel drive for forward propulsion on land. (5) Air duct to front lift cell. (6) Hydraulic suspension. This regulates the weight taken by the wheels on land and lowers them when in water. (7) 140 h.p. engine driving the two air lift fans. (8) Fan air and hydraulic controls. (9) Bevel drive to fans. (10) Fan drive shaft. (11) Air supply to lift cells. (12) Air inlet grille

to fans. (13) Flexible lift cells adapt themselves to rough ground for passing over an obstacle. (14) One of the flexible lift cells - four each side and one front and rear of vehicle. (15) Air supply to lift cells can be regulated individually. (16) Fan air to lift cells. (17) Fan drive shaft. (18) Air supply to fan. (19) Air ducts to lift cells. (20) Air cushion effect on ground (or water) gives the vehicle lift and spreads the load over a large area. (21) Air inlet grille to fans. (22) Rear hydraulic suspension. (23) Air duct to rear lift cell. (24) Underfloor 45 h.p. engine driving rear wheels. (25) One of three fuel tanks.



# IT'S FANTASTIC...



One of the most interesting V.T.O.L. projects undergoing wind tunnel tests is this retractable fan aircraft. Six jet fans (see sketch below) are built into the fuselage of the fighter, enabling it to take off vertically from unprepared and small bases.

Once in the air, jet thrust moves the machine forward until it is travelling fast enough to retract the fans into the fuselage and use its wings for support. In small local wars, mobility is the most important factor and, as 9,000-ft. concrete runways cannot be built overnight, fighters and bombers capable of S/V.T.O.L. are most important.

The Ryan Company of the U.S.A. is just one concern which has given serious attention to S/V.T.O.L. problems.

## KEY TO NUMBERED PARTS

(1) A pair of engines which provide all the power needed for take off and horizontal supersonic flight. (2) Jet thrust is bled off the engines for vertical take off and fed through ducts (3) and (4) to the six fans (5) and (6), which direct thrust downwards. This gas-thrust blows through the duct round the edge of the fan over small vanes attached to the fan blades, thereby making them spin. The small sketch shows a detail of the duct and vanes of the aft

fans which spin in an anti-clockwise direction. The forward fans spin in a clockwise direction. (7) and (8) Edge of the port fans. (9) One of the pair of jet pipes. (10) Space into which fans retract. (11) Sidewinder air-to-air missile. (12) T-171 E3 Gatling gun in pod. This 20 mm. cannon fires 6,000 rounds per minute or 100 per second! (13) Pylon for fitting bombs, rockets, fuel tanks, etc. (14) Di-electric nose made of fibre-glass and heat-resistant paint containing navigation and battle radar. (15) Air intakes for main engines. (16) 200-gallon wing-tip tank. Supersonic fighters carry tanks or missiles on both wings - never a mixture of the two.

V-T-O-L  
S-T-O-L

## TWO NEW PRINCIPLES

### ...IT'S A GAS!

This lighter-than-air (L.T.A.) machine was built by the Aereon Corporation in New Jersey, U.S.A., to prove that gas-filled machines can still play a big part in commercial aviation.

The name, *Aereon III*, comes from the name given to two L.T.A. ships built by a Dr Solomon in the 19th century. He called them *Aereon I* and *II*.

Present-day aircraft rely on what is known as manufactured lift - i.e., lift created by the fast movement of the craft through the air, whether empty or loaded. For example, the *B.A.C. III* has an empty take-off weight of 44,226 lb. before putting any cargo aboard, and, like any aeroplane, it needs a runway. On the other hand, the *Aereon III* basic airframe weighs a mere 2,800 lb. which, when filled with non-inflammable gas, is reduced to 700 lb. The wing sections between the triple fuselages are equal in area to most modern passenger/cargo machines, and therefore the aerodynamic lift is, apart from 700 lb., applied to lifting the payload.

These L.T.A. machines will never be as fast as modern jets, so their big commercial value lies in transporting heavy and bulky items to remote areas. An *Aereon* ship carrying, say, a 10-ton generator, would need only a patch of gravel or sand to land on, whereas most aircraft capable of carrying this load would require masses of navigational aids and 9,000 feet of expensive runway.

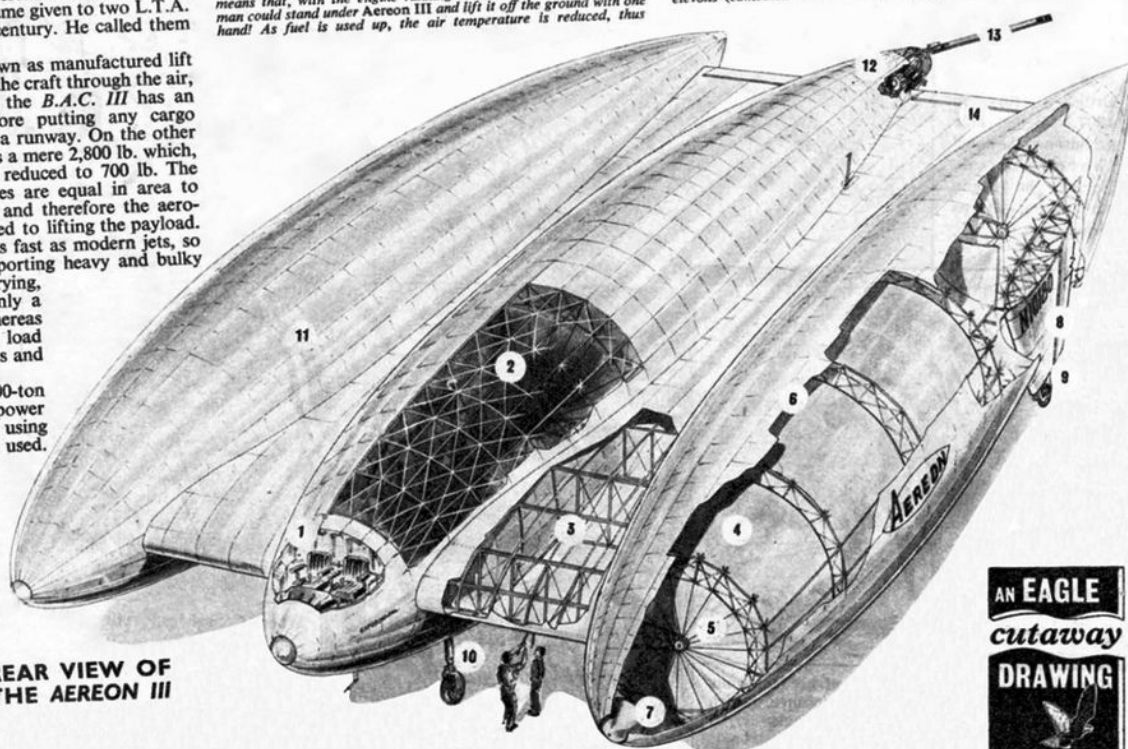
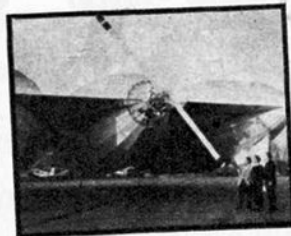
Larger *Aereons* capable of carrying 100-ton loads are planned. Because of the low power required to take off, multi-fuel engines using Diesel fuel, paraffin, petrol, etc., can be used.

## KEY TO NUMBERED PARTS

(1) Cockpit for pilot and co-pilot. Larger *Aereon* L.T.A. ships will carry a flight engineer and navigator. The engineer will be able to service the engine and airframe in the air to save time on the ground. (2) Enormously-strong geodesic structure which was invented by Barnes Wallis, the famous designer of the dam-buster bomb, swing wings, etc. (3) Very light structure in wing construction. (4) 40,000 cubic feet of helium gas is contained in 18 interconnected cells in the 85-foot-long fuselages. (5) Bicycle-wheel structure cells in the fuselage gives *Aereon* rigidity. (6) Engine heat exchanger provides 'thermo-lift'. This is gained by using waste heat from engine and pumping the heated air into the space between the outer-skin and the helium cells. By heating the air and making the helium more buoyant, as much as 600 lb. more lift is gained. This means that, with the engine running and heating the air space, a man could stand under *Aereon III* and lift it off the ground with one hand! As fuel is used up, the air temperature is reduced, thus

reducing buoyancy and providing the same wing loading from take off to landing. (7) Valve in the nose of *Aereon* allows air to feed into space between cells and outer skin. This pressurization adds rigidity to the whole structure in bad conditions. (8) Rudder adds rigidity to the whole structure in bad conditions. (9) Wheel. When brake and fin under the outboard fuselages only. (10) Wheel. When brake and fin under the outboard fuselages only. (11) Outer skin is smooth, wind. This prevents storm damage. (12) Solar Titan gas-the need for *Aereon* ever to go into a hangar. (13) This is turbine engine developing 80 h.p. and weighing only 50 lb. This is smaller than the gas-turbine engine in the Rover gas-turbine car! (14) 18-foot helicopter rotor turned on end. With its ability to change pitch and head its axis 12 degrees in any direction, amazing control can be attained while travelling at speeds too low for elevons (combined elevators and ailerons) (14) to operate.

REAR VIEW OF THE AEREON III

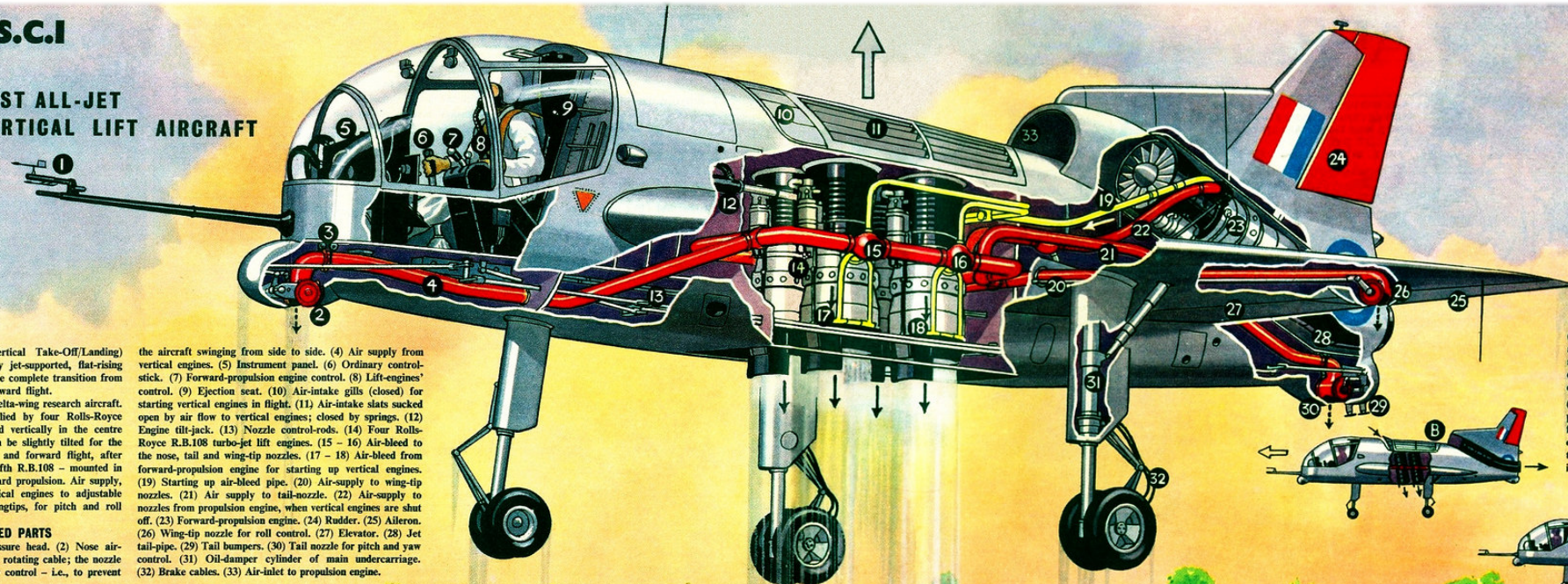


AN EAGLE  
cutaway  
DRAWING



# SHORT S.C.I

## WORLD'S FIRST ALL-JET VERTICAL LIFT AIRCRAFT



This British jet-lift VTOL (Vertical Take-Off/Landing) research aircraft is the first fully jet-supported, flat-rising aircraft in the world to demonstrate complete transition from vertical rising and hovering to forward flight.

The Short S.C.I is a single-seat, delta-wing research aircraft. Lift for vertical take-off is supplied by four Rolls-Royce RB.108 turbo-jet engines, mounted vertically in the centre of the fuselage. These engines can be slightly tilted for the transition period between vertical and forward flight, after which they are shut off, and the fifth R.B.108 - mounted in the tail - provides power for forward propulsion. Air supply, or bleed, is taken from the vertical engines to adjustable nozzles in the nose, tail and wingtips, for pitch and roll control of the aircraft.

### KEY TO NUMBERED PARTS

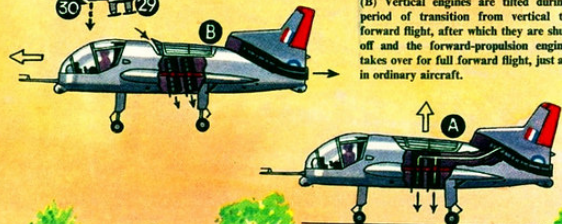
(1) Directional vanes and air-pressure head. (2) Nose air-nozzle for pitch control. (3) Nozzle rotating cable; the nozzle can be turned horizontally for yaw control - i.e., to prevent

the aircraft swinging from side to side. (4) Air supply from vertical engines. (5) Instrument panel. (6) Ordinary control-stick. (7) Forward-propulsion engine control. (8) Lift-engines' control. (9) Ejection seat. (10) Air-intake gills (closed) for starting vertical engines in flight. (11) Air-intake slats sucked open by air flow to vertical engines; closed by springs. (12) Engine tilt-jack. (13) Nozzle control-rods. (14) Four Rolls-Royce R.B.108 turbo-jet lift engines. (15 - 16) Air-bleed to the nose, tail and wing-tip nozzles. (17 - 18) Air-bleed from forward-propulsion engine for starting up vertical engines. (19) Starting up air-bleed pipe. (20) Air-supply to wing-tip nozzles. (21) Air supply to tail-nozzle. (22) Air-supply to nozzles from propulsion engine, when vertical engines are shut off. (23) Forward-propulsion engine. (24) Rudder. (25) Aileron. (26) Wing-tip nozzle for roll control. (27) Elevator. (28) Jet tail-pipe. (29) Tail bumpers. (30) Tail nozzle for pitch and yaw control. (31) Oil-damper cylinder of main undercarriage. (32) Brake cables. (33) Air-inlet to propulsion engine.

### METHOD OF FLIGHT

(A) Air-bleed from propulsion engine acts on the vertical engine turbine-blades and starts up the engines. Air-flow to engines is sucked in through slats above, causing aircraft to rise.

(B) Vertical engines are tilted during period of transition from vertical to forward flight, after which they are shut off and the forward-propulsion engine takes over for full forward flight, just as in ordinary aircraft.





# THE FLYING FATTY

A monster cargo aircraft known as the Colossal Guppy is being planned by Aero Spacelines of America. Already it has large capacity planes called the Guppy family but this latest addition will outshine them all. This strange-looking monster with a fuselage 40 feet in diameter will be large enough to carry the U.S. Saturn S-2 rocket or 18 Bell helicopters—alternative cargo could be freight containers. For the sake of comparison in size we show double-decker buses in the lower hold—6 of these could be carried, each weighing 11 tons. A huge cargo door in the nose, operated by hydraulic power, opens sideways complete with crew cockpit, all controls having adjustable connections. The plane will be about 200 feet long with a wing span of 220 feet. Mounted on pylons beneath the wings will be no fewer than 12 Pratt and Whitney turbojet engines giving a top speed of 450 m.p.h., fully loaded. Aero Spacelines is not a very big company but they certainly think big.



Below: A resemblance to the Guppy aircraft in Nature. The Achilles Tang fish of the Indian Ocean—Nature had it first.

## KEY TO NUMBERED PARTS

(1) Flight cockpit with crew of four. (2) Nose wheels retracted. (3) Lower cargo floor joint. (4) Hydraulically-powered door hinge. (5) Inner twin turbojet engines. (6) Leading edge slats or air flow spoilers. (7) Engine pylon mounting bracket. (8) Middle twin Pratt and Whitney turbojet engines. (9) Outer twin turbojet engines. (10) Port wing drop fuel tank. (11) Port ailerons. (12) Port split flaps for take-off and landing. (13) Wing fuel tanks. (14) Port main undercarriage retracted. (15) Double-decker buses in lower hold, for comparison only. (16) Hydraulically-powered door hinge. (17) Cargo door opening ring. (18) Middle twin turbojet engines. (19) Outer twin turbojet engines. (20) Alternative cargo freight containers. (21) Lower hold for mixed freight. (22) Freight containers. (23) Rear end of upper deck. (24) Rudder and elevator controls. (25) Elevators. (26) Rudder.

A section of the huge 40-ft. diameter fuselage, showing double-decker buses for size. 18 Bell helicopters could be carried, each weighing 3½ tons—10 on the upper deck, 8 on the lower



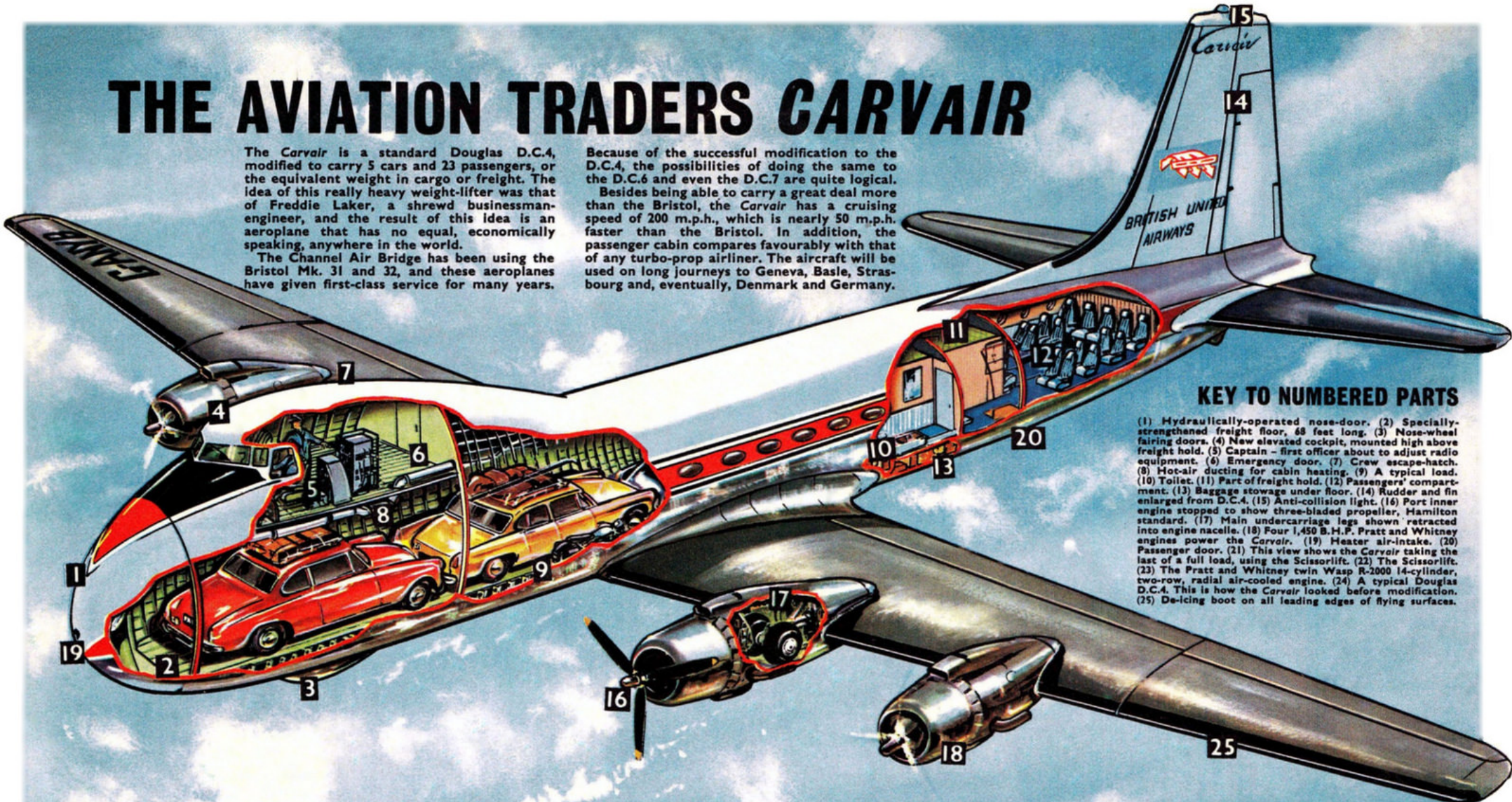
# THE AVIATION TRADERS *CARVAIR*

The *Carvair* is a standard Douglas D.C.4, modified to carry 5 cars and 23 passengers, or the equivalent weight in cargo or freight. The idea of this really heavy weight-lifter was that of Freddie Laker, a shrewd businessman-engineer, and the result of this idea is an aeroplane that has no equal, economically speaking, anywhere in the world.

The Channel Air Bridge has been using the Bristol Mk. 31 and 32, and these aeroplanes have given first-class service for many years.

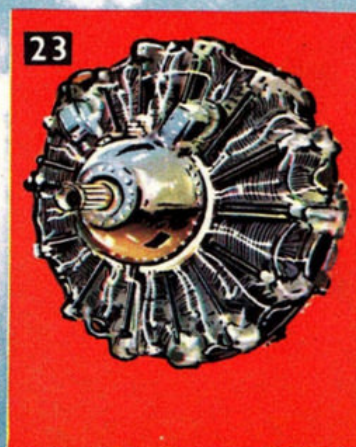
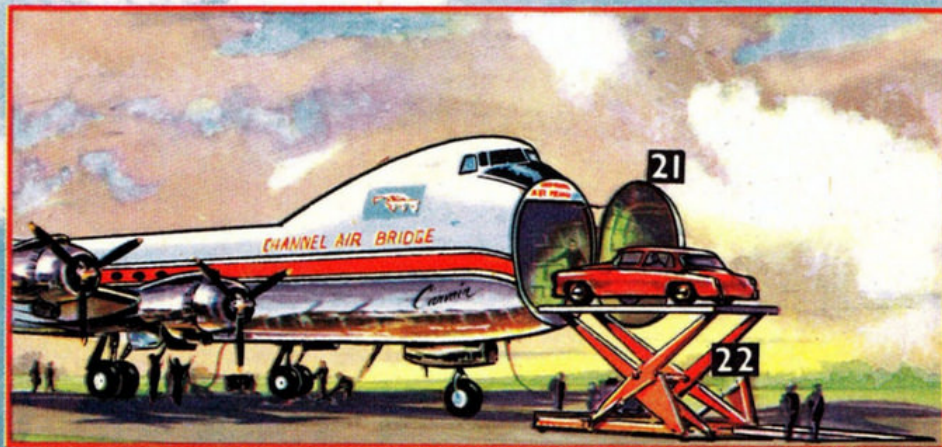
Because of the successful modification to the D.C.4, the possibilities of doing the same to the D.C.6 and even the D.C.7 are quite logical.

Besides being able to carry a great deal more than the Bristol, the *Carvair* has a cruising speed of 200 m.p.h., which is nearly 50 m.p.h. faster than the Bristol. In addition, the passenger cabin compares favourably with that of any turbo-prop airliner. The aircraft will be used on long journeys to Geneva, Basle, Strasbourg and, eventually, Denmark and Germany.



## KEY TO NUMBERED PARTS

(1) Hydraulically-operated nose-door. (2) Specially-strengthened freight floor, 68 feet long. (3) Nose-wheel fairing doors. (4) New elevated cockpit, mounted high above freight hold. (5) Captain - first officer about to adjust radio equipment. (6) Emergency door. (7) Crew escape-hatch. (8) Hot-air ducting for cabin heating. (9) A typical load. (10) Toilet. (11) Part of freight hold. (12) Passengers' compartment. (13) Baggage stowage under floor. (14) Rudder and fin enlarged from D.C.4. (15) Anti-collision light. (16) Port inner engine stopped to show three-bladed propeller, Hamilton standard. (17) Main undercarriage legs shown retracted into engine nacelle. (18) Four 1,450 B.H.P. Pratt and Whitney engines power the *Carvair*. (19) Heater air-intake. (20) Passenger door. (21) This view shows the *Carvair* taking the last of a full load, using the Scissorlift. (22) The Scissorlift. (23) The Pratt and Whitney twin Wasp R-2000 14-cylinder, two-row, radial air-cooled engine. (24) A typical Douglas D.C.4. This is how the *Carvair* looked before modification. (25) De-icing boot on all leading edges of flying surfaces.





# WORK-HORSE OF THE AIR



The old 'Rapide' biplane which has now finished 15 years of faithful service

THE Isles of Scilly—a tiny speckle of islands 35 miles out in the Atlantic from the tip of Cornwall—have enjoyed a regular air service to the mainland since 1937. In those early days, one flight a day in each direction was operated between a mainland field at St Just and a golf course on St Mary's island, where a boy with a handbell warned golfers of the approach of the aircraft!

Over the 25 years that this air service has been in operation, traffic has increased both in passengers and freight in the form of the spring flowers for which the Isles of Scilly are so famous. As a result, B.E.A. Helicopters Ltd. have introduced a new service using two Sikorsky helicopters to replace the old seven-seater De Havilland Rapide biplanes which have given faithful service on this run for the past 15 years.

These S.N.61 helicopters are ideally suited for the short-haul service between the grass airfields on the mainland and the Isles of Scilly. Later this year, the old airfield at St Just will be abandoned for a new Heliport under construction near Penzance.

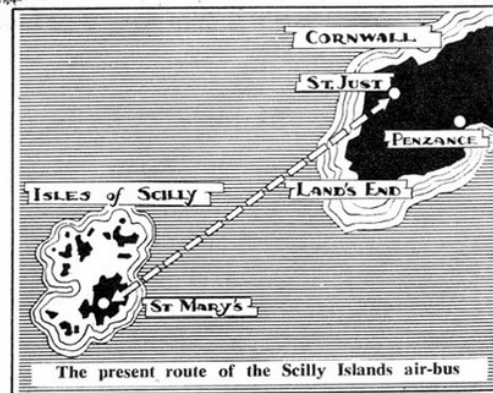
## KEY TO NUMBERED PARTS:

(1) Pilot's seat. (2) Co-pilot's seat. (3) Shrouded instrument panel. (4) Control column operating the rotor blades. (5) Yaw pedals controlling tail rotor blades. (6) Wheel brake pedal.

(7) Rotor brake lever. (8) Downward observation windows. (9) Side window. (10) Windscreen washer nozzles. (11) Foot-operated windscreen washer control. (12) Windscreen wipers. (13) Outside air temperature probe. (14) Cockpit lamp. (15) Battery compartment. (16) Door to radio and electronic compartment. (17) Towing and anchor shackle. (18) Forward rotating beacon. (19) Landing light. (20) Navigation lights. (21) Engines—two General Electric CT58-110-1 gas turbines, each developing 1,250 s.h.p. (22) Engine air intakes. (23) Oil tanks. (24) Starter motor. (25) Turbine exhaust trunk. (26) Gearbox. (27) Drop-down inspection and working platforms. (28) Rotor spider, to which the five rotor blades (29) are attached. These 62-foot diameter blades are made of lightweight alloy. (30) Buttons at the root of each blade, which show red if nitrogen pressure falls. (31) Swash-plate and linkage for controlling the pitch of the rotor blades by the servo-cylinders (32) which are operated by the control column. (33) Oil cooler, belt driven from the tail rotor drive shaft (34). (35) Intermediate gearbox. (36) Tail rotor gearbox. (37) Stabilizing tail rotor. (38) Linkage controlling pitch of tail rotor blades. (39) Tailplane. (40) Rear rotating beacon. (41) Tail boom. (42) Passengers' entrance. (43) Combined drop-down steps and door. (44) Passenger space arranged with single seats on the port side and double seats on the starboard side. (45) Passengers' emergency exit. (46) Freight space. (47) Freight loading doors. (48) Air intake for cabin heating system. (49) Cold air inlet to cabin. (50) Boat-section hull bottom divided into seven watertight compartments (51). (52) Fuel tanks. (53) Outrigger side floats. (54) Shock-absorbing under-carriage strut. (55) Retractable main landing gear, fitted with disc brakes. (56) Mooring and ground towing ring. (57) Fixed rear wheel. (58) Aft mooring and ground towing ring. (59) Direction-finding loop and sense aerials. (60) V.H.F. communication aerial. (61) Pitot head (non-revolving) for air speed indication.



AN EAGLE  
cutaway  
DRAWING





# BIG SWING-WINGER FROM RUSSIA



The MIG VG with wings in the fully forward position

## KEY TO NUMBERED PARTS

Now the Soviet Union is swinging — a previously unknown swing-wing air-craft has made a public appearance and is scheduled for production. Some details have been revealed and the aircraft bears a striking resemblance to the American F-111, which is on order for the R.A.F., except that it is a single-engine single-seater fighter.

Known as the MIG VG (Mikoyan Gurevich), this swing-winger is powered by a TDR turbojet engine or 25,000-pounds thrust with after-burner, and has a top speed of about Mach 2.5 (1,900 m.p.h.) A big main fin and a large neutral fin under, typical MIG features, give the aircraft a distinctive appearance. The wings can be fully swept backward for high speeds and forward for lower speeds and landing. The all-moving swept tailpiece acts as elevators and ailerons-elevons.

The MIG VG has impressed all observers with its performance and appears to be designed for home defence.

Span: 28ft. (fully swept), 50ft. 6ins. (fully forward); length: 59ft.; height: 17ft.

(1) Radar probe. (2) Search radar scanner. (3) Main electronics bay. (4) Steerable nose wheels (retracted). (5) Air entry for boundary layer over wings. (6) Air entry to engine trunks (both sides). (7) Single-seater cockpit and ejector seat. (8) Control runs for swing-wings. (9) Forward fixed wing section. (10) Fuel tanks. (11) Starboard wing pivot. (12) Hydraulic motors operating screw-jacks. (13) Steel bridge for wing pivots. (14) Swing-wing screw-jacks. Screw outwards for sweep back—retract for bringing forward. (15) Port wing pivot. (16) Swing-wing brackets. (17) Position of wing when fully forward. (18) Air-to-air missile. (19) Pivoted missile carrier. (20) Fuel cells in swing-wing flexible pipes move with the pivot. (21) Bifurcated (split) engine air trunks. (22) Air chambers to engine fan. (23) TDR turbojet engine. (24) Swing-wing in fully swept position. (25) Ventral fin. (26) Tail-plane activator. (27) Moving tail-plane or elevon. (28) Afterburner giving a total thrust of 25,000 pounds. (29) Jet nozzle. (30) Braking parachute container, used when landing. (31) Rudder. (32) Infra-red tail warning light.

ASHWELL  
WOOD



# THE BIGGEST PLANE IN THE WORLD

**T**HIS monster, now being built by Lockheeds of Georgia, U.S.A., will have a loaded weight of 340 tons. It is almost impossible to conceive that anybody will ever want to build a bigger aircraft.

The C-5A will have the strength, speed and range to carry U.S. tanks, helicopters, trucks and 75 troops from America to any trouble spot in the world within 24 hours.

The huge cargo interior is 121 ft. long; 13 ft. 6 ins. wide and 19 ft. high. Cruising speed is 520 m.p.h. and range 5,500 miles according to payload.

The four General Electric by-pass turbofan jet engines suspended below the wings on pylons have the terrific thrust of 41,000 lb. each.

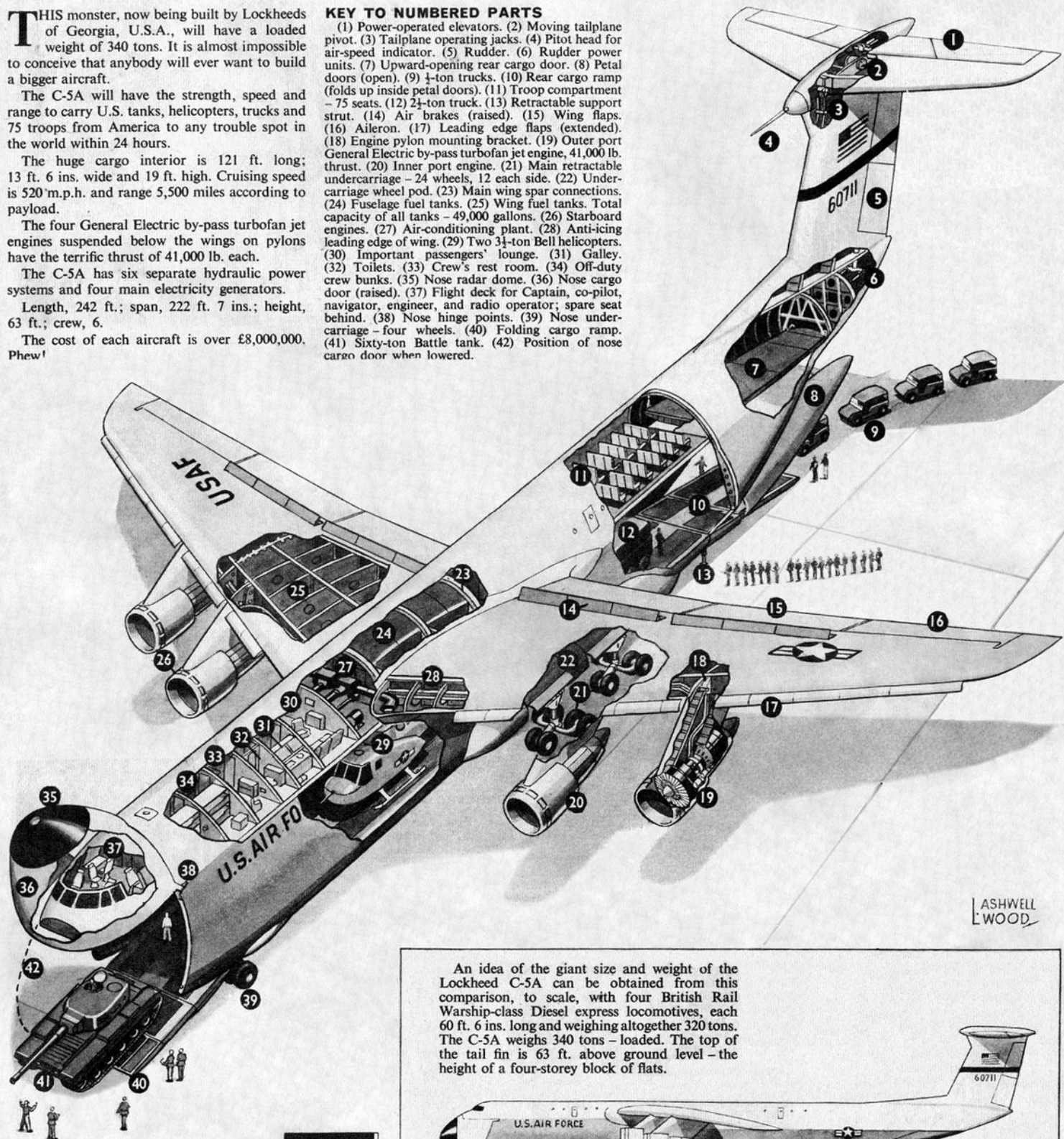
The C-5A has six separate hydraulic power systems and four main electricity generators.

Length, 242 ft.; span, 222 ft. 7 ins.; height, 63 ft.; crew, 6.

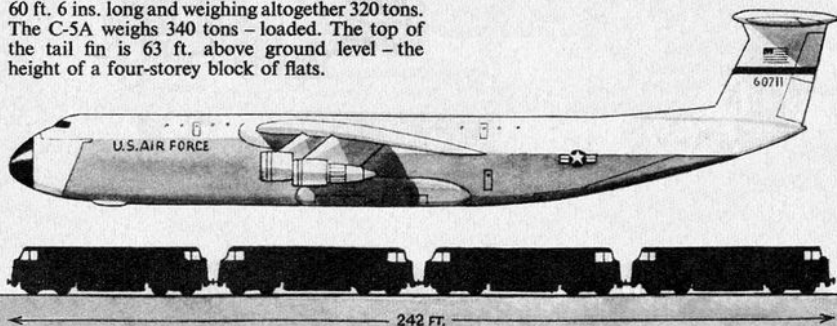
The cost of each aircraft is over £8,000,000. Phew!

## KEY TO NUMBERED PARTS

(1) Power-operated elevators. (2) Moving tailplane pivot. (3) Tailplane operating jacks. (4) Pitot head for air-speed indicator. (5) Rudder. (6) Rudder power units. (7) Upward-opening rear cargo door. (8) Petal doors (open). (9) 4-ton trucks. (10) Rear cargo ramp (folds up inside petal doors). (11) Troop compartment - 75 seats. (12) 24-ton truck. (13) Retractable support strut. (14) Air brakes (raised). (15) Wing flaps. (16) Aileron. (17) Leading edge flaps (extended). (18) Engine pylon mounting bracket. (19) Outer port General Electric by-pass turbofan jet engine, 41,000 lb. thrust. (20) Inner port engine. (21) Main retractable undercarriage - 24 wheels, 12 each side. (22) Undercarriage wheel pod. (23) Main wing spar connections. (24) Fuselage fuel tanks. (25) Wing fuel tanks. Total capacity of all tanks - 49,000 gallons. (26) Starboard engines. (27) Air-conditioning plant. (28) Anti-icing leading edge of wing. (29) Two 3½-ton Bell helicopters. (30) Important passengers' lounge. (31) Galley. (32) Toilets. (33) Crew's rest room. (34) Off-duty crew bunks. (35) Nose radar dome. (36) Nose cargo door (raised). (37) Flight deck for Captain, co-pilot, navigator, engineer, and radio operator; spare seat behind. (38) Nose hinge points. (39) Nose undercarriage - four wheels. (40) Folding cargo ramp. (41) Sixty-ton Battle tank. (42) Position of nose cargo door when lowered.



An idea of the giant size and weight of the Lockheed C-5A can be obtained from this comparison, to scale, with four British Rail Warship-class Diesel express locomotives, each 60 ft. 6 ins. long and weighing altogether 320 tons. The C-5A weighs 340 tons - loaded. The top of the tail fin is 63 ft. above ground level - the height of a four-storey block of flats.



AN EAGLE  
cutaway  
DRAWING



# THE WORLD'S FIRST CRESCENT WING BOMBER

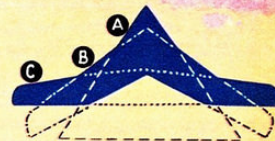
Fastest, furthest and highest, with the greatest bomb load of any in the world, is an apt description of Britain's Handley Page *Victor*, the first crescent (or scimitar) wing aircraft. The four-jet *Victor* is in super-priority production for the Royal Air Force. Behind the *Victor's* outstanding performance lies its crescent wing, in which thickness and sweepback are progressively decreased from root to tip. Each wing has three phases. The first, nearest the body, is thickest and steeply swept-back. It contains the 'buried' jet engines, four Armstrong Siddeley *Sapphires*, each of 8,300 pounds thrust, two in each wing. The middle wing section is considerably thinner and less swept-back, while the outermost section is still thinner and still less swept-back. These factors are designed to reduce drag at sonic or near sonic speeds. Britain leads in the shape of wings to come.

## KEY TO PARTS

(1) Swept-back tail plane and elevators. (2) Staggered fin and rudder. (3) Rudder and elevator controls. (4) Air brake controls. (5) Air brake flaps (one each side) extended for reducing air speed. (6) Starboard aileron. (7) Two-piece nose flaps on leading edge, used for take off, landing and slow flight. (8) Rear flaps. (9-9) Starboard wing fuel tanks. (10) Eight-wheeled bogie of starboard main undercarriage (retracted). (11) Outer starboard Armstrong Siddeley *Sapphire* jet engine. (12) Inner starboard jet engine. (13) Air ducts to engines. (14) Cooling air intake to engine auxiliaries. (15)

Air intakes to engines. (16) Main fuel tank. (17) Double nose wheel (retracted). (18) Secret radar and radio equipment. (19) Bomb-aimer's window. (20) Captain and second pilot. (21) Navigator. (22) Flight engineer's panel. (23) Radio operator. (24) Crew's entrance door. (25) Eight-wheeled bogie of port main undercarriage (retracted). (26) Rear flap operating cowl. (27-27) Port wing fuel tanks. (28) Port aileron. (29) Nose flaps. (30) Thickest and most steeply swept-back wing section. (31) Thinner and less swept-back middle wing section. (32) Still thinner and still less swept-back outer wing section.

Relative scale proportions. Actual dimensions not available.



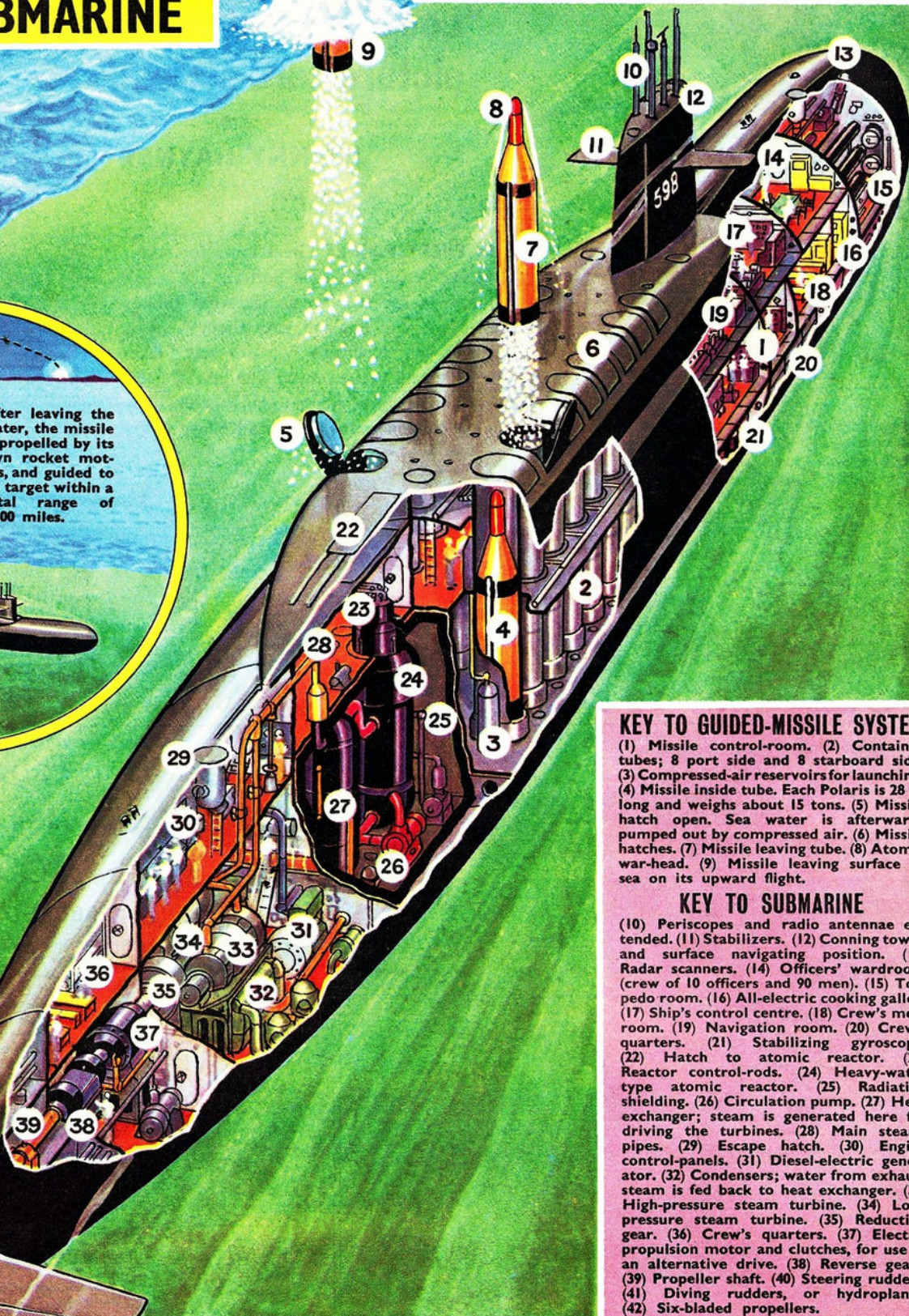
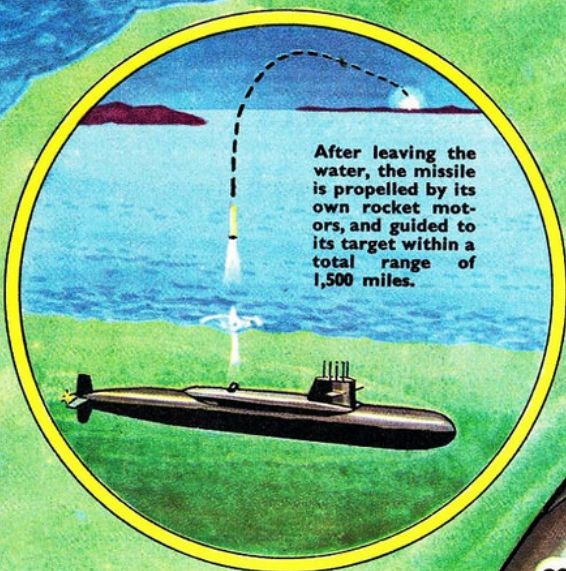
An exaggerated diagram showing how the crescent wing combines the merits of other wing shapes in reducing drag at high speeds. (a) Delta wing. (b) Straight swept-back. (c) Straight thin wing.



# POLARIS

## ATOMIC SUBMARINE

Polaris is the name given to the ballistic guided-missiles fired from a submerged submarine. The United States Navy atomic-powered submarine *George Washington* is shown here launching two such missiles. The submarine has a range of about 100,000 miles, enabling it to circle the world several times without refuelling. These magnificent vessels cost about £30,000,000 each, and each missile - of which 16 are carried - costs about £300,000.



### KEY TO GUIDED-MISSILE SYSTEM

(1) Missile control-room. (2) Container tubes; 8 port side and 8 starboard side. (3) Compressed-air reservoirs for launching. (4) Missile inside tube. Each Polaris is 28 ft. long and weighs about 15 tons. (5) Missile hatch open. Sea water is afterwards pumped out by compressed air. (6) Missile hatches. (7) Missile leaving tube. (8) Atomic war-head. (9) Missile leaving surface of sea on its upward flight.

### KEY TO SUBMARINE

(10) Periscopes and radio antennae extended. (11) Stabilizers. (12) Conning tower and surface navigating position. (13) Radar scanners. (14) Officers' wardroom (crew of 10 officers and 90 men). (15) Torpedo room. (16) All-electric cooking galley. (17) Ship's control centre. (18) Crew's mess room. (19) Navigation room. (20) Crew's quarters. (21) Stabilizing gyroscope. (22) Hatch to atomic reactor. (23) Reactor control-rods. (24) Heavy-water type atomic reactor. (25) Radiation shielding. (26) Circulation pump. (27) Heat exchanger; steam is generated here for driving the turbines. (28) Main steam-pipes. (29) Escape hatch. (30) Engine control-panels. (31) Diesel-electric generator. (32) Condensers; water from exhaust steam is fed back to heat exchanger. (33) High-pressure steam turbine. (34) Low-pressure steam turbine. (35) Reduction gear. (36) Crew's quarters. (37) Electric propulsion motor and clutches, for use as an alternative drive. (38) Reverse gears. (39) Propeller shaft. (40) Steering rudders. (41) Diving rudders, or hydroplanes. (42) Six-bladed propellers.

*George Washington* Atomic-Powered submarine No. 598, on surface. Length, 382 ft.; beam, 32 ft.; 12,500 h.p. Weight, 5,400 tons (surface), 6,700 tons (submerged). Speed, 28 knots (surface), 20 knots (submerged).



L. ASHWELL  
L. WOOD



# CARGO-CARRYING COLOSSUS

Straddle carriers designed to move containers up to 40 ft. long and weighing up to 30 tons will speed handling of cargo at the new berths being built at Tilbury Docks - Britain's first ocean container port.

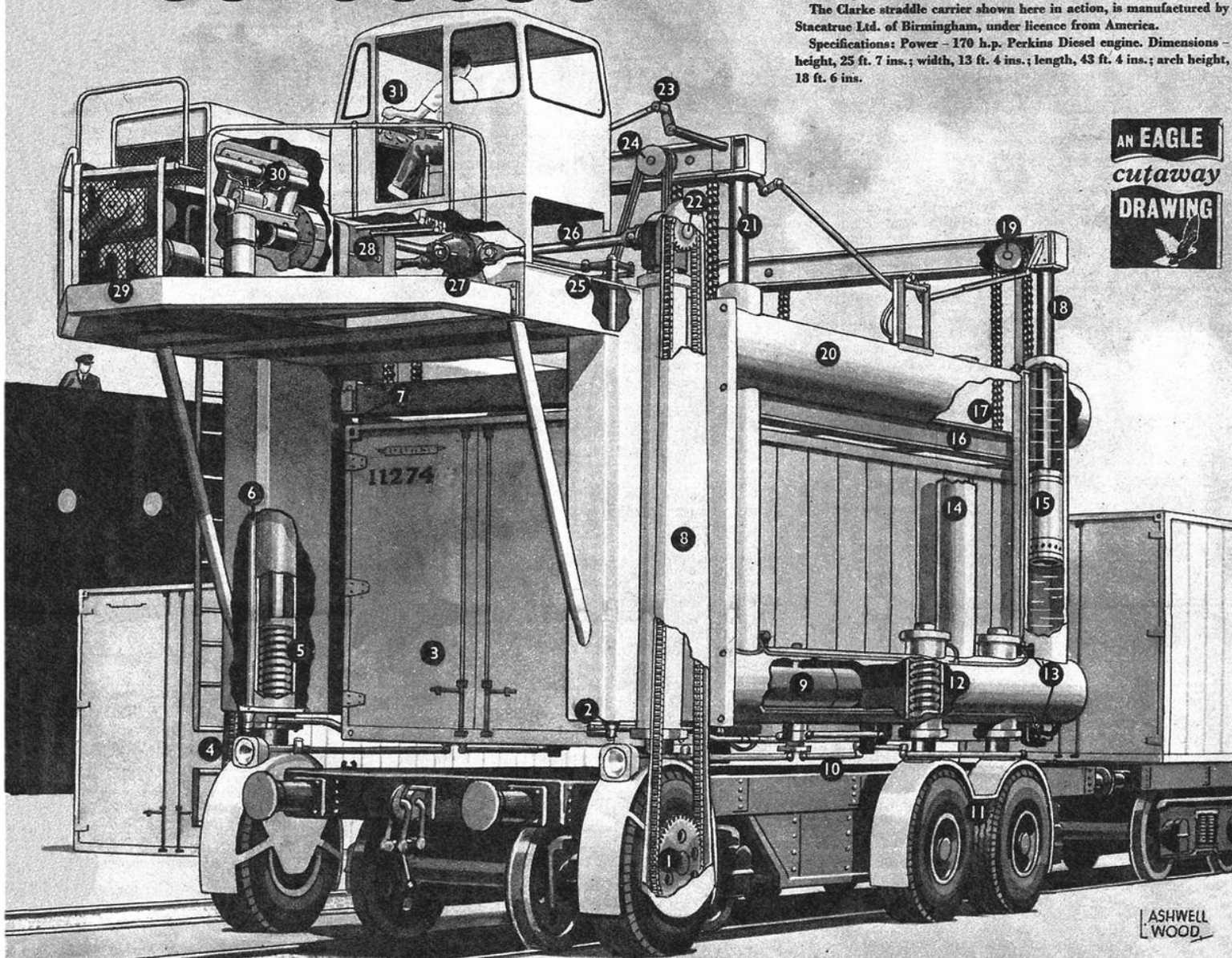
The Port of London Authority has ordered 12 of these carriers at a cost of nearly half a million pounds. They straddle-carry (hence the name) containers from ships direct on to a waiting lorry or rail wagon or carry them to a container parking area.

The idea of cargo containers is shipping's biggest revolution since steam. Containers pack up to 30 tons of goods in a 'metal box' and over 1,000 'boxes' fit into a special ship which sails in and out of port in 12 hours - against seven days for an ordinary cargo ship.

The Clarke straddle carrier shown here in action, is manufactured by Stacatrac Ltd. of Birmingham, under licence from America.

Specifications: Power - 170 h.p. Perkins Diesel engine. Dimensions - height, 25 ft. 7 ins.; width, 13 ft. 4 ins.; length, 43 ft. 4 ins.; arch height, 18 ft. 6 ins.

AN EAGLE  
cutaway  
DRAWING

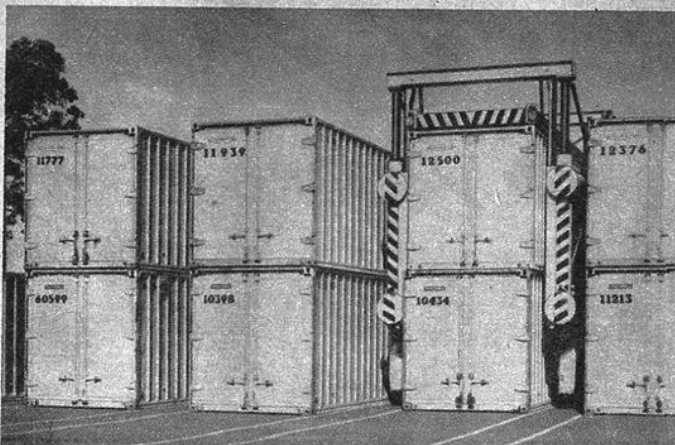


Below: Rear-end view of a straddle carrier positioned over containers in a container parking area. The carrier can stack 40-foot-long containers two high and can pick one up in 18 seconds

## KEY TO NUMBERED PARTS

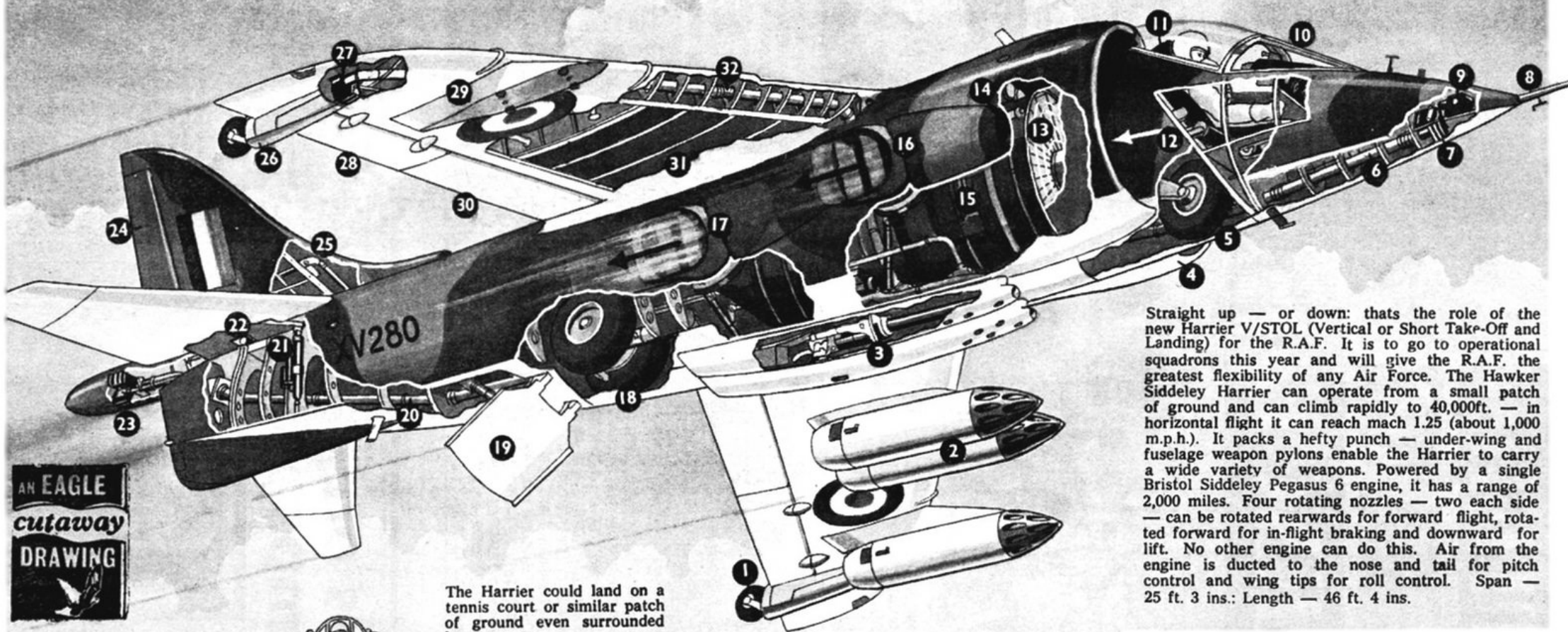
(1) Front wheel chain drive gear. (2) Steering rod arm. (3) Loaded container weighing 30 tons being lowered on to railway flat truck. (4) Front wheel chain drive. (5) Coil spring and hydraulic damper wheel suspension. (6) Steering rod. (7) Lift frame with lifting hooks at each corner hydraulically operated. The hooks engage a pocket on top of the container. (8) Chain drive casing. (9) Hydraulic oil reservoir. (10) Steering rods—all six wheels steer. (11) Steerable rear wheels with brake drums. (12) Coil spring wheel suspension. (13) Hydraulic cylinder valves. (14) Support beam. (15) Hydraulic pistons (two each side) for raising the lift frame and container. (16) Lift frame. (17) Roller chain fixed to each corner of lift frame. (18) Piston rod. (19) Roller chain pulley. (20) Main frame steel tubes. (21)

Piston rod and roller chain. (22) Gear wheel and chain drive to front wheel. (23) Sensing device controlling four valves and the oil flow to the hydraulic pistons. This enables an unevenly-loaded container to be handled in a horizontal position. (24) Lift frame shifting control, which enables the frame to be accurately positioned over a container. (25) Steering connection to power-assisted steering wheel in operator's cab. (26) Drive shaft to chain drive (each side). (27) Crown wheel and bevel drive from engine. (28) Five speed and reverse gearbox. (29) Engine-driven hydraulic pumps, etc. (30) V-eight cylinder Perkins 170 h.p. Diesel engine. (31) Operator's cab, which is the nerve-centre of the carrier, with all hydraulic controls, engine control and gear-change lever.





# LOOK—NO RUNWAY!



AN EAGLE  
cutaway  
DRAWING

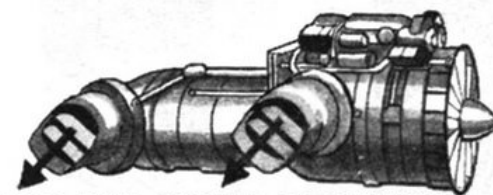
ASHWELL  
L'WOOD

The Harrier could land on a tennis court or similar patch of ground even surrounded by trees

Straight up — or down: that's the role of the new Harrier V/STOL (Vertical or Short Take-Off and Landing) for the R.A.F. It is to go to operational squadrons this year and will give the R.A.F. the greatest flexibility of any Air Force. The Hawker Siddeley Harrier can operate from a small patch of ground and can climb rapidly to 40,000ft. — in horizontal flight it can reach mach 1.25 (about 1,000 m.p.h.). It packs a hefty punch — under-wing and fuselage weapon pylons enable the Harrier to carry a wide variety of weapons. Powered by a single Bristol Siddeley Pegasus 6 engine, it has a range of 2,000 miles. Four rotating nozzles — two each side — can be rotated rearwards for forward flight, rotated forward for in-flight braking and downward for lift. No other engine can do this. Air from the engine is ducted to the nose and tail for pitch control and wing tips for roll control. Span — 25 ft. 3 ins.; Length — 46 ft. 4 ins.

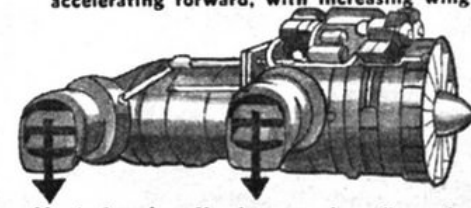
## KEY TO NUMBERED PARTS

(1) Wing tip landing wheel retracted. (2) Rocket launchers. (3) Two 30 m.m. Aden guns. (4) Port engine air duct. (5) Steerable nose wheel retracted. (6) Air duct to nose pitch control. (7) Nose pitch control. (8) Pilot probe for air speed indication. (9) Camera. (10) Bird-proof windscreen. (11) Martin-Baker Mk9 ejection seat. (12) Starboard engine air duct. (13) First stage engine compressor fan. (14) Air duct to cooling radiator. (15) Bristol Siddeley Pegasus 6 turbo-jet engine of 20,000 pound thrust. (16) Rotating nozzle for cold fan air discharge. (17) Rotating nozzle for hot gas jet — both nozzles rotated backwards for forward flight. (18) Main undercarriage retracted. (19) Air brake-down. (20) Air duct to tail pitch control. (21) Tail plane operating jack. (22) Tail plane pivot — tail plane acts as elevators. (23) Tail pitch control also yaw (side to side) control. (24) Rudder. (25) Rudder controls. (26) Wing tip landing wheel retracted. (27) Wing tip roll control. (28) Aileron. (29) Outer weapons pylon. (30) Flaps for take-off and landing. (31) Fuel tanks in wings and top of fuselage. (32) Air duct to wing tip roll control.



## CHANGING FROM VERTICAL TO HORIZONTAL FLIGHT

Transition: Jet nozzles rotating rearwards. Aircraft accelerating forward, with increasing wing lift.



Vertical take-off. Jet nozzles directed vertically down. Aircraft lifted off the ground under full engine thrust.



# THE FLAMING PENCIL

## FACTS ABOUT THE WORLD'S FASTEST CONVENTIONAL AIRCRAFT

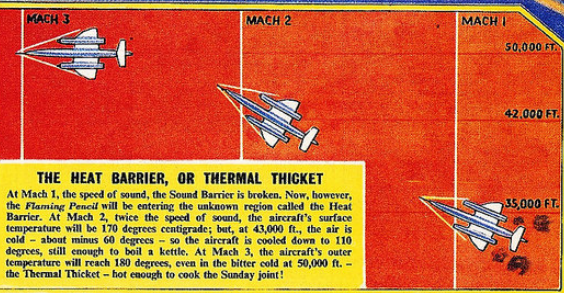
At present known as the Bristol 188, this supersonic research aircraft is intended for investigations into problems of extreme high-speed flight and the 'heat barrier' at speeds of 2,000 m.p.h. A great deal of information will be contributed towards the evolution of future supersonic airliners. The *Flaming Pencil* is of all-welded stainless steel construction, with some parts made of ceramics (or pottery) - this is necessary to withstand the white-hot temperatures of the air blasting across the skin of the aircraft. At the temperatures and speeds involved, other metals would break up. This swept-back-wing aircraft is powered by two De Havilland Gyron Junior jet engines, with after-burners, mounted in wing nacelles. What a far cry from the Bristol Box-Kite of 50 years ago!

### KEY TO THE OUTSTANDING FEATURES

(1) Air-speed probe. (2) Secret electronic equipment. (3) Radar dish. (4) Electronics. (5) Pilot in thermal protective clothing. He just fits into the 3 ft. 9 in.-wide fuselage. (6) Hinged metal canopy. (7) Retractable nose-wheel. (8) Research-instrument bay. (9) Control runs. (10) Fuel tanks. (11) Starboard engine nacelle. (12) Welded stainless steel construction. (13) Power-driven elevators-cum-flaps. (14) Ram-jet type air-intake to engine. (15) Guide vanes. (16) De Havilland Gyron Junior jet engine. (17) Axial flow air-compressors. (18) Annular combustion chambers and turbine wheel-casing. (19) Jet pipe. (20) After-burner; this re-heats the jet efflux and gives extra thrust. (21) Controllable jet-exhaust nozzle. (22) Power-controlled, balanced aileron. (23) Air brakes. (24) Braking parachute for landing. (25) Swept-back rudder. (26) Power drive for tail-plane. (27) One-piece movable tailplane.

### THE HEAT BARRIER, OR THERMAL THICKET

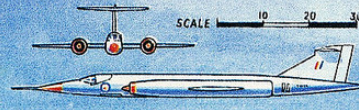
At Mach 1, the speed of sound, the Sound Barrier is broken. Now, however, the *Flaming Pencil* will be entering the unknown region called the Heat Barrier. At Mach 2, twice the speed of sound, the aircraft's surface temperature will be 170 degrees centigrade; but, at 43,000 ft., the air is cold - about minus 60 degrees - so the aircraft is cooled down to 110 degrees, still enough to boil a kettle. At Mach 3, the aircraft's outer temperature will reach 180 degrees, even in the bitter cold at 50,000 ft. - the Thermal Thicket - hot enough to cook the Sunday joint!



ASHWELL WOOD

**BRISTOL 188**  
Span, 35 ft. 1 in.  
Length (without probe), 71 ft.  
Height, 13 ft. 4 ins.  
Top Speed, 2,000 m.p.h.?

SCALE 10 20 30 FEET





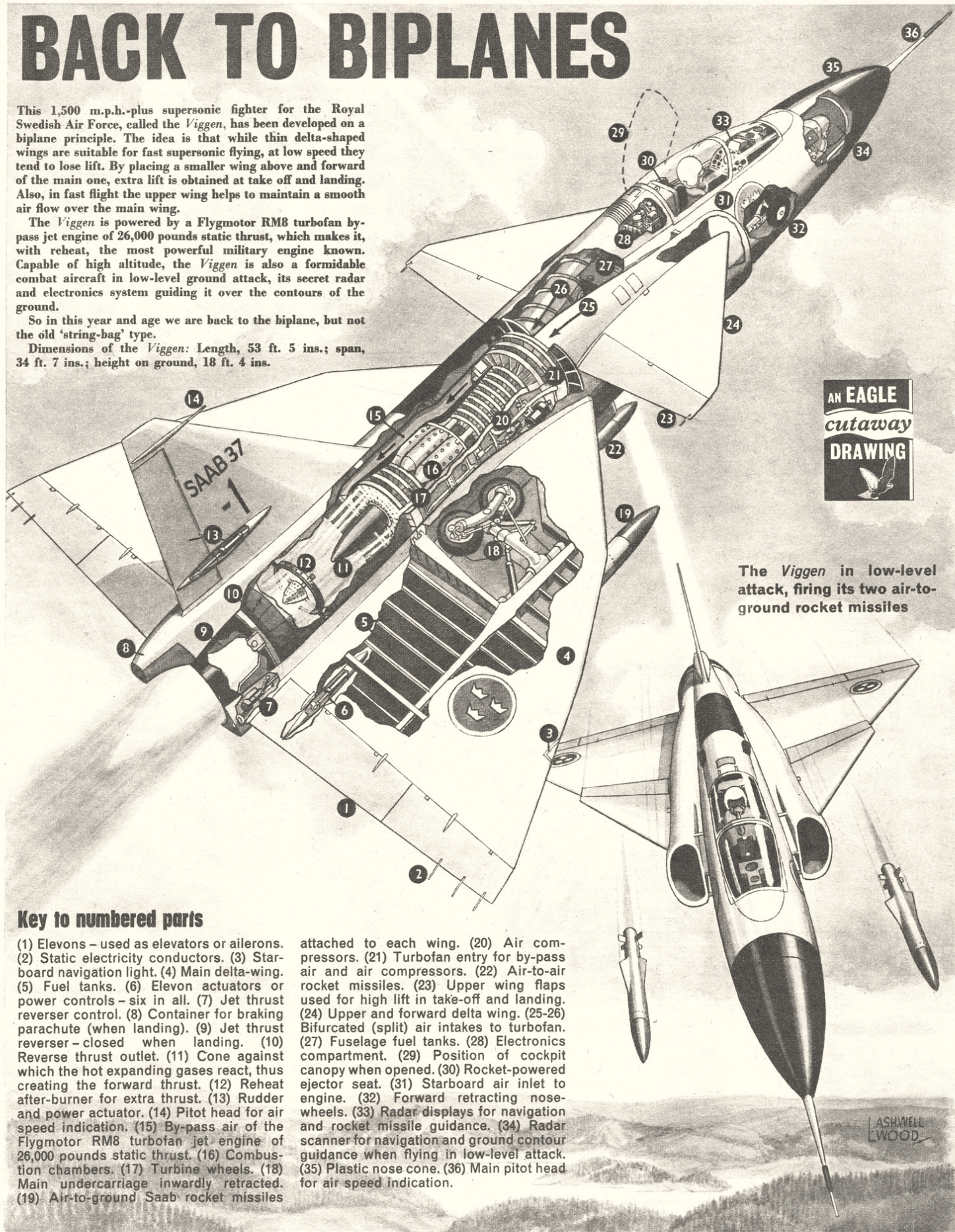
# BACK TO BIPLANES

This 1,500 m.p.h.-plus supersonic fighter for the Royal Swedish Air Force, called the *Viggen*, has been developed on a biplane principle. The idea is that while thin delta-shaped wings are suitable for fast supersonic flying, at low speed they tend to lose lift. By placing a smaller wing above and forward of the main one, extra lift is obtained at take off and landing. Also, in fast flight the upper wing helps to maintain a smooth air flow over the main wing.

The *Viggen* is powered by a Flygmotor RM8 turbofan bypass jet engine of 26,000 pounds static thrust, which makes it, with reheat, the most powerful military engine known. Capable of high altitude, the *Viggen* is also a formidable combat aircraft in low-level ground attack, its secret radar and electronics system guiding it over the contours of the ground.

So in this year and age we are back to the biplane, but not the old 'string-bag' type.

Dimensions of the *Viggen*: Length, 53 ft. 5 ins.; span, 34 ft. 7 ins.; height on ground, 18 ft. 4 ins.



AN EAGLE  
cutaway  
DRAWING

The *Viggen* in low-level attack, firing its two air-to-ground rocket missiles

## Key to numbered parts

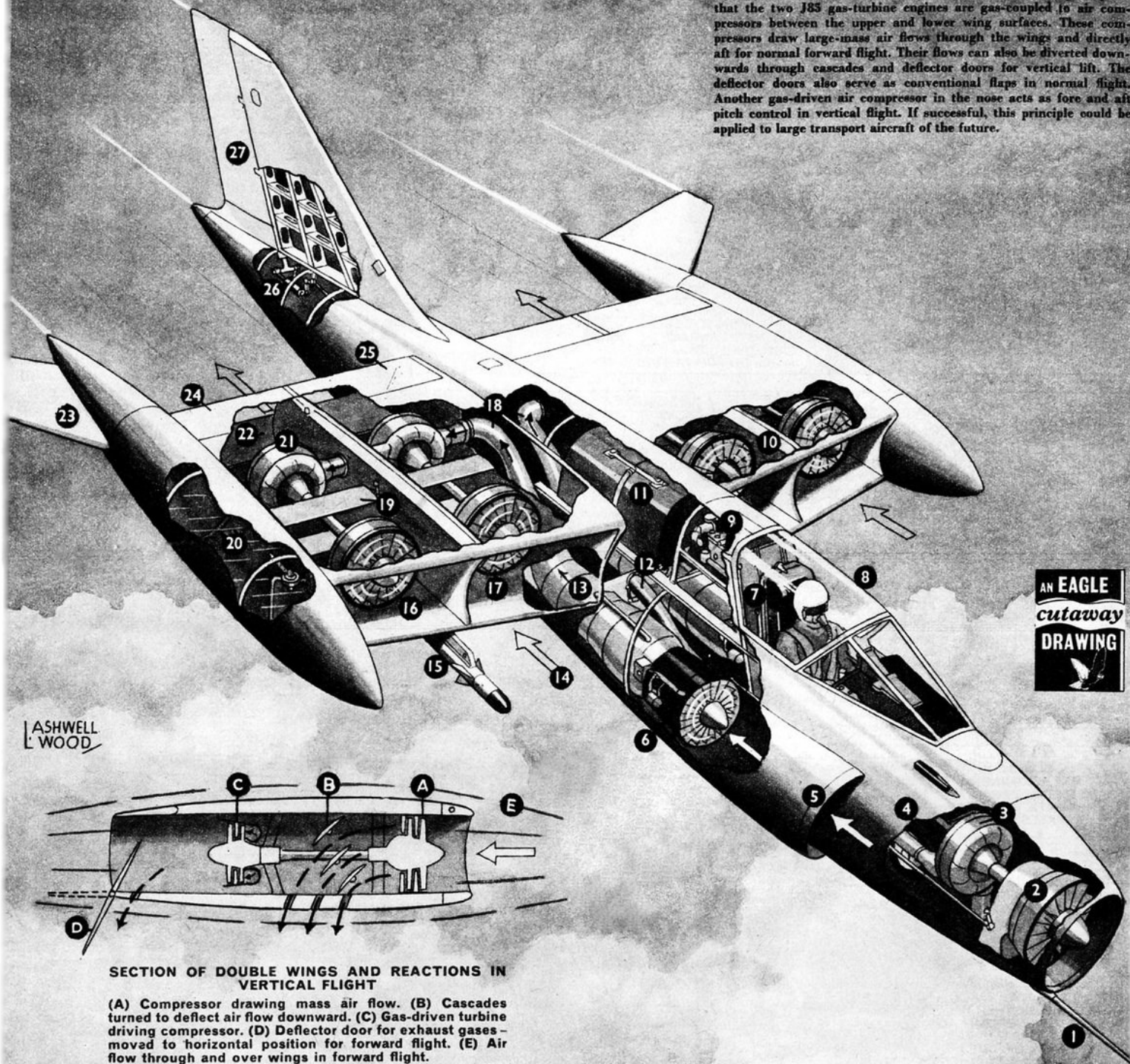
(1) Elevons - used as elevators or ailerons. (2) Static electricity conductors. (3) Starboard navigation light. (4) Main delta-wing. (5) Fuel tanks. (6) Elevon actuators or power controls - six in all. (7) Jet thrust reverser control. (8) Container for braking parachute (when landing). (9) Jet thrust reverser - closed when landing. (10) Reverse thrust outlet. (11) Cone against which the hot expanding gases react, thus creating the forward thrust. (12) Reheat after-burner for extra thrust. (13) Rudder and power actuator. (14) Pitot head for air speed indication. (15) By-pass air of the Flygmotor RM8 turbofan jet engine of 26,000 pounds static thrust. (16) Combustion chambers. (17) Turbine wheels. (18) Main undercarriage inwardly retracted. (19) Air-to-ground Saab rocket missiles

attached to each wing. (20) Air compressors. (21) Turbofan entry for by-pass air and air compressors. (22) Air-to-air rocket missiles. (23) Upper wing flaps used for high lift in take-off and landing. (24) Upper and forward delta wing. (25-26) Bifurcated (split) air intakes to turbofan. (27) Fuselage fuel tanks. (28) Electronics compartment. (29) Position of cockpit canopy when opened. (30) Rocket-powered ejector seat. (31) Starboard air inlet to engine. (32) Forward retracting nose-wheels. (33) Radar displays for navigation and rocket missile guidance. (34) Radar scanner for navigation and ground contour guidance when flying in low-level attack. (35) Plastic nose cone. (36) Main pitot head for air speed indication.



# BIPLANE FIGHTER OF THE FUTURE

You will not find this plane in your spotters' books - yet. It is a unique VTOL (Vertical Take-Off Landing) fighter of the future. To be known as the *Adam II*, full-scale wind-tunnel tests are now being made in America. The aircraft is effectively a biplane. Briefly, the principle is that the two J85 gas-turbine engines are gas-coupled to air compressors between the upper and lower wing surfaces. These compressors draw large-mass air flows through the wings and directly aft for normal forward flight. Their flows can also be diverted downwards through cascades and deflector doors for vertical lift. The deflector doors also serve as conventional flaps in normal flight. Another gas-driven air compressor in the nose acts as fore and aft pitch control in vertical flight. If successful, this principle could be applied to large transport aircraft of the future.



AN EAGLE  
cutaway  
DRAWING

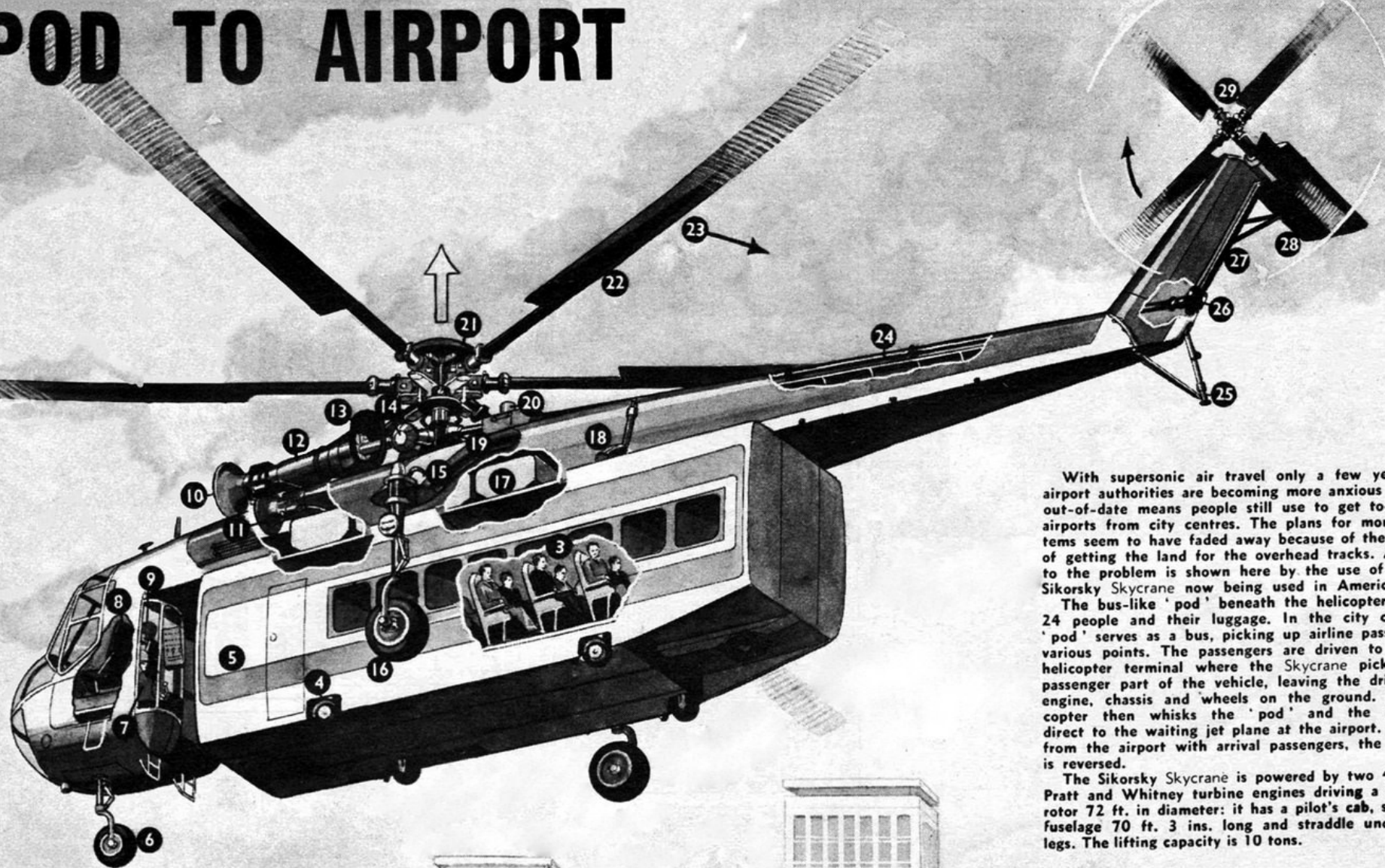
## KEY TO NUMBERED PARTS

(1) Pitot tube for air-speed indication. (2) Forward air compressor for aircraft pitch control. (3) Gas-driven turbine driving compressor. (4) Nose-wheel retracted. (5) Air intake for engines (both sides). (6) Starboard J85 gas-turbine engine. Both engines supply gases to the compressor turbines through ducts and valves—and also give thrust for forward flight. (7) Ejection seat. (8) Cockpit canopy. (9) Electronics bay. (10) Port wing air compressors. (11) Fuel tanks. (12) Gas duct and valve for forward compressor turbine. (13) Main gas duct. (14) Mass air flow through wings. (15) Air-to-air missiles. (16) Outer starboard compressor drawing mass air through wings. (17) Inner starboard compressor. (18) Gas ducts to all four turbines. (19) Deflector cascades in horizontal position for forward flight. (20) Outer fuel tanks. (21) Gas-driven turbines (four) driving air compressors. (22) Deflector door which also acts as a flap in normal flight. (23) Roll stabilizer fins. (24) Ailerons. (25) Elevators. (26) Rudder power-control unit. (27) Rudder and fin construction.





# AIR-POD TO AIRPORT



With supersonic air travel only a few years away, airport authorities are becoming more anxious about the out-of-date means people still use to get to and from airports from city centres. The plans for monorail systems seem to have faded away because of the high cost of getting the land for the overhead tracks. A solution to the problem is shown here by the use of the huge Sikorsky Skycrane now being used in America.

The bus-like 'pod' beneath the helicopter can hold 24 people and their luggage. In the city centre the 'pod' serves as a bus, picking up airline passengers at various points. The passengers are driven to a central helicopter terminal where the Skycrane picks up the passenger part of the vehicle, leaving the driver's cab, engine, chassis and wheels on the ground. The helicopter then whisks the 'pod' and the passengers direct to the waiting jet plane at the airport. Returning from the airport with arrival passengers, the procedure is reversed.

The Sikorsky Skycrane is powered by two 4,050 h.p. Pratt and Whitney turbine engines driving a six-bladed rotor 72 ft. in diameter: it has a pilot's cab, spinal type fuselage 70 ft. 3 ins. long and straddle undercarriage legs. The lifting capacity is 10 tons.

## Key to Numbered Parts

(1) Driver's cab, engine and chassis left on the ground. (2) Position of passenger pod when attached to chassis. (3) Seating for 24 passengers. (4) Extendable support wheels when pod is placed on the ground at the airport. (5) Passengers' luggage compartment. (6) Nose wheel. (7) Rearward-facing crane operator's seat and lifting controls. (8) Co-pilot's seat, in forward flight. The Co-pilot also acts as crane operator. (9) Pilot. (10-11) Air intakes to engines. (12) Pratt and Whitney 4,050 h.p. turbine engines. (13) Engine exhaust. (14) Engine drive to rotor gearbox. (15) Straddle undercarriage legs. (16) Main undercarriage wheels. (17) Fuel tanks. (18) Load carrying points (four) with hydraulic jacks. (19) Tail rotor drive from gearbox. (20) Hydraulic controls. (21) Rotor head controls blade pitch and lift. (22) Six-bladed 72 ft.-diameter rotor. (23) Direction of rotation. (24) Tail rotor drive shaft. (25) Rear Skid. (26) Intermediate gearbox. (27) Drive to tail rotor gearbox. (28) Stabilizing tail plane. (29) 16 ft.-diameter tail rotor. This acts as rudder for directional stability.

The pod lowered to the ground on arrival at the airport. It will be picked up later with passengers for the return journey to the city centre.





# WORLD'S FIRST VERTICAL TAKE-OFF AIRLINER

A novel British aircraft, the Fairey Rotodyne, recently made its successful first flight. It is powered by two Napier Eland propeller-jet engines of 3,500 h.p. each. For vertical take-off and landing, compressed air is piped from the engines to small jet units at the tips of the rotor blades, here the air mixes with burning paraffin and the jet exhaust reaction causes the blades to rotate.

For level flight the engine power is transferred to the propellers and the Rotodyne then flies as a normal fixed-wing aircraft. Part of the lift is supplied by the short fixed wing, and part by the 'free-wheeling' rotor blades which revolve without being driven by their jets.

The heli-liner, a new name in aircraft, can carry 40 passengers and freight at 185 m.p.h., and has a range of 430 miles.

## VERTICAL TAKE-OFF AND FORWARD FLIGHT

(A) Most of the power of the engines is used to supply compressed air to the rotor tip jets. The blades rotate and the machine rises vertically like a helicopter.

(B) Collective pitch for vertical flight.

(C) The rotor head is tilted, cyclic pitch, to assist forward movement, until the power is gradually transferred to the propellers.

(D) Full power for forward flight. The rotors will now rotate on their own, because of the forward passage of the aircraft.

**KEY TO POWER SYSTEM:** (1) Napier Eland propeller-jet engine of 3,500 h.p. combined propeller and jet thrust for forward flight. (2) Variable pitch propeller. (3) Axial flow air compressor. Air intake is round propeller hub. (4) Combustion chamber. (5) Turbine wheels. (6) Jet exhaust (both sides of engine nacelle). (7) Air intake to auxiliary compressor. (8) Auxiliary compressor driven from engine through a clutch. (9) Compressed air to rotor head and blade tips (shown in red). (10) Rotor blade pitch changing links (called 'collective pitch' for vertical flight). The whole rotor head can be tilted - 'cyclic pitch' - for forward, backwards or sideways flight. (11) Pitch operating jacks. (12) Fuel supply to rotor blades (shown in yellow). (13) Air supply through hollow shaft to three pipe lines in rotor blade. (14) Fuel (paraffin) pipe. (15) Ignition line. (16) 90 ft. rotor blade. (17) Blade tip jet unit. The fuel is mixed with the air and ignited. (18) Jet exhaust, the reaction of which causes the blade to rotate. (19) Direction of rotation.

**KEY TO OTHER PARTS:** (20) Cyclic pitch control. Collective pitch control on pilot's left hand. (21) Rudder control pedals. All controls are duplicated for second pilot. (22) Clear downwards view windows. (23) Forward retracting nose wheels. (24) Radio racks. (25) Gallery. (26) Entrance door. (27) Pitch control rods. (28) Collective and cyclic pitch controls to operating jacks (No. 11). (29) Gearbox for pumps, generator, etc. (30) Bag-type fuel tanks. (31) Rearwards retracting main undercarriage (starboard). (32) Cable for 40 passengers. (33) Freight compartment. The interior can be arranged in a variety of ways, i.e., for 3 medium sized cars and 12 passengers, or all freight, or for 40 passengers. (34) Toilet. (35) Rudder controls. (36) Trim controls. (37) Trim flaps, these can act as elevators. (38) Tail splits into two doors for loading. (39) Starboard fin. (40) Starboard rudder.

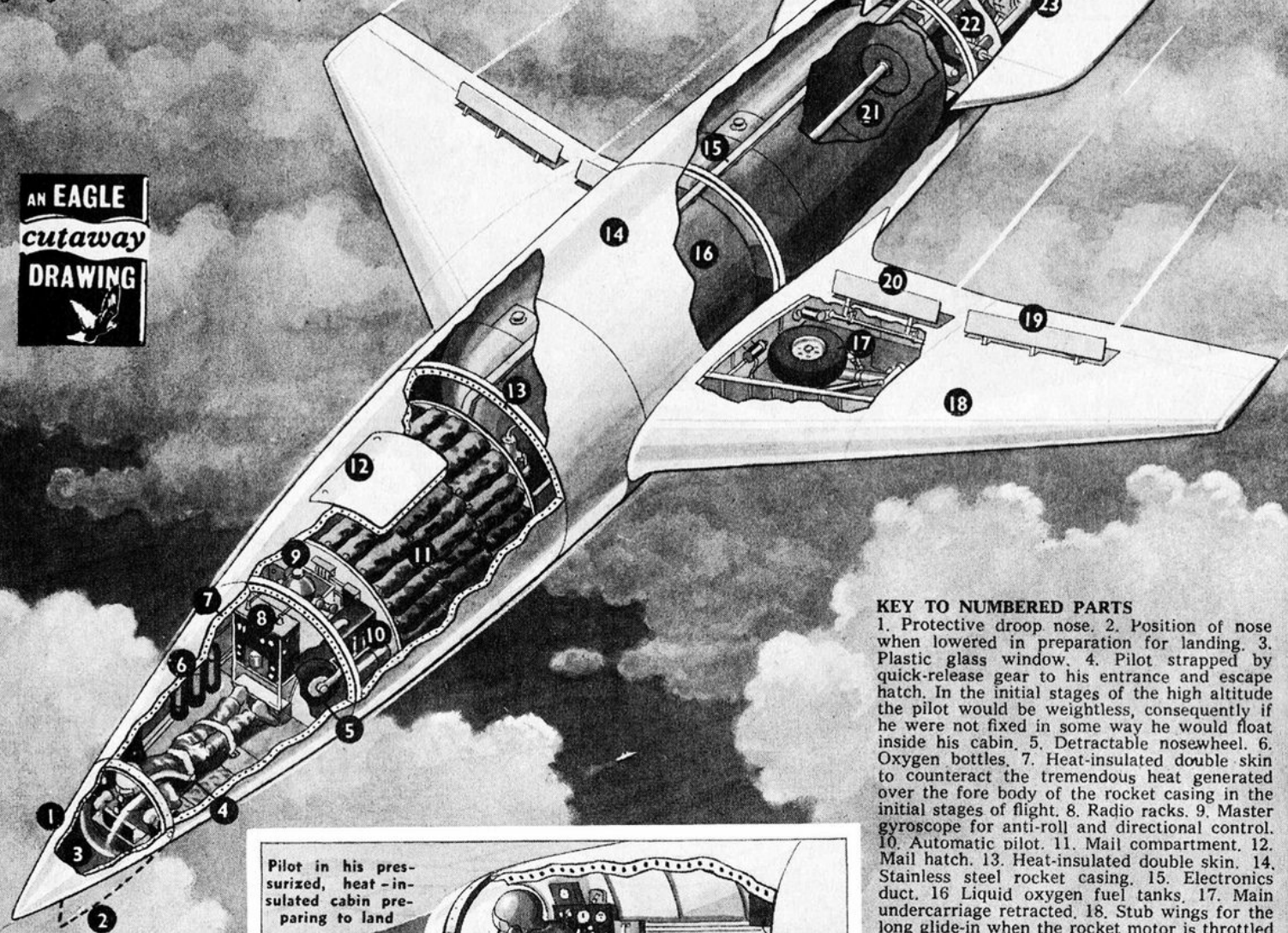


# ROCKET AIR MAIL TO AMERICA

## (IN 45 MINUTES)

The development of a winged rocket with human control which could fly from Europe to America in three-quarters of an hour is an Anglo-German project of the near future. It is no fantasy, but a forecast based on scientific information obtained from the experience of present-day space rockets. The speed of the air mail rocket would be in the region of 8,000 m.p.h. Hurling from its discharge point to a height of about 200 miles above the earth, the rocket would describe a curve and fall at tremendous speed. When it reached a point in its downward trajectory, about 30 miles above the earth, the pilot would take control, pull up the nose and put the rocket into a long glide across the Atlantic Ocean. It would then gradually lose speed, until, nearing its destination, the pilot would lower the droop nose, sight his landing ground through a plastic glass window, lower the undercarriage and land at about 80 m.p.h. The pilot would be assisted by gyroscopic control and automatic course-keeping equipment. The 'cargo' could consist of top priority or urgent diplomatic mail, or anything that would justify getting across the Atlantic in double-quick time.

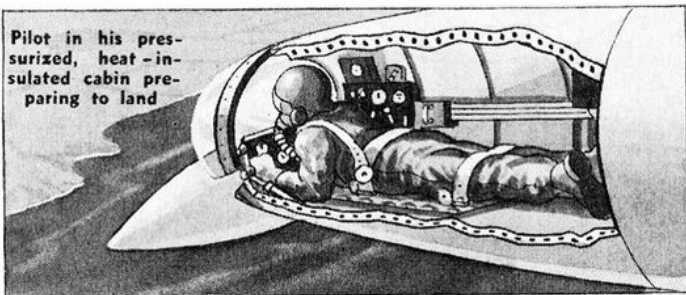
AN EAGLE  
cutaway  
DRAWING



### KEY TO NUMBERED PARTS

1. Protective droop nose. 2. Position of nose when lowered in preparation for landing. 3. Plastic glass window. 4. Pilot strapped by quick-release gear to his entrance and escape hatch. In the initial stages of the high altitude the pilot would be weightless, consequently if he were not fixed in some way he would float inside his cabin. 5. Retractable nosewheel. 6. Oxygen bottles. 7. Heat-insulated double skin to counteract the tremendous heat generated over the fore body of the rocket casing in the initial stages of flight. 8. Radio racks. 9. Master gyroscope for anti-roll and directional control. 10. Automatic pilot. 11. Mail compartment. 12. Mail hatch. 13. Heat-insulated double skin. 14. Stainless steel rocket casing. 15. Electronics duct. 16. Liquid oxygen fuel tanks. 17. Main undercarriage retracted. 18. Stub wings for the long glide-in when the rocket motor is throttled back. 19-20. Lift spoilers—would be raised in preparation for landing. 21. Liquid alcohol fuel tank. 22. Electronics bay. 23. Turbines and fuel pump assembly. 24. Stabilizing fins. 25. Rocket motor combustion chamber. 26. Rocket exhaust nozzle. 27. Gyro-controlled rudders—top and under. 28. Gyro-controlled elevator-ailerons.

Pilot in his pressurized, heat-insulated cabin preparing to land



### Path of the human-controlled rocket air mail

A. Top trajectory of rocket—speed 7,500 m.p.h. B. Path to earth if the rocket was not controlled. C. Pilot begins to take over—speed 8,250 m.p.h. D. Long flat glide made possible by speed at fall. E. End of glide path and approach to land at about 80 m.p.h. Time of flight 45 minutes

AMERICA

3,000

2,000

MILES

1,000

HEIGHT  
IN MILES

200

100

EUROPE

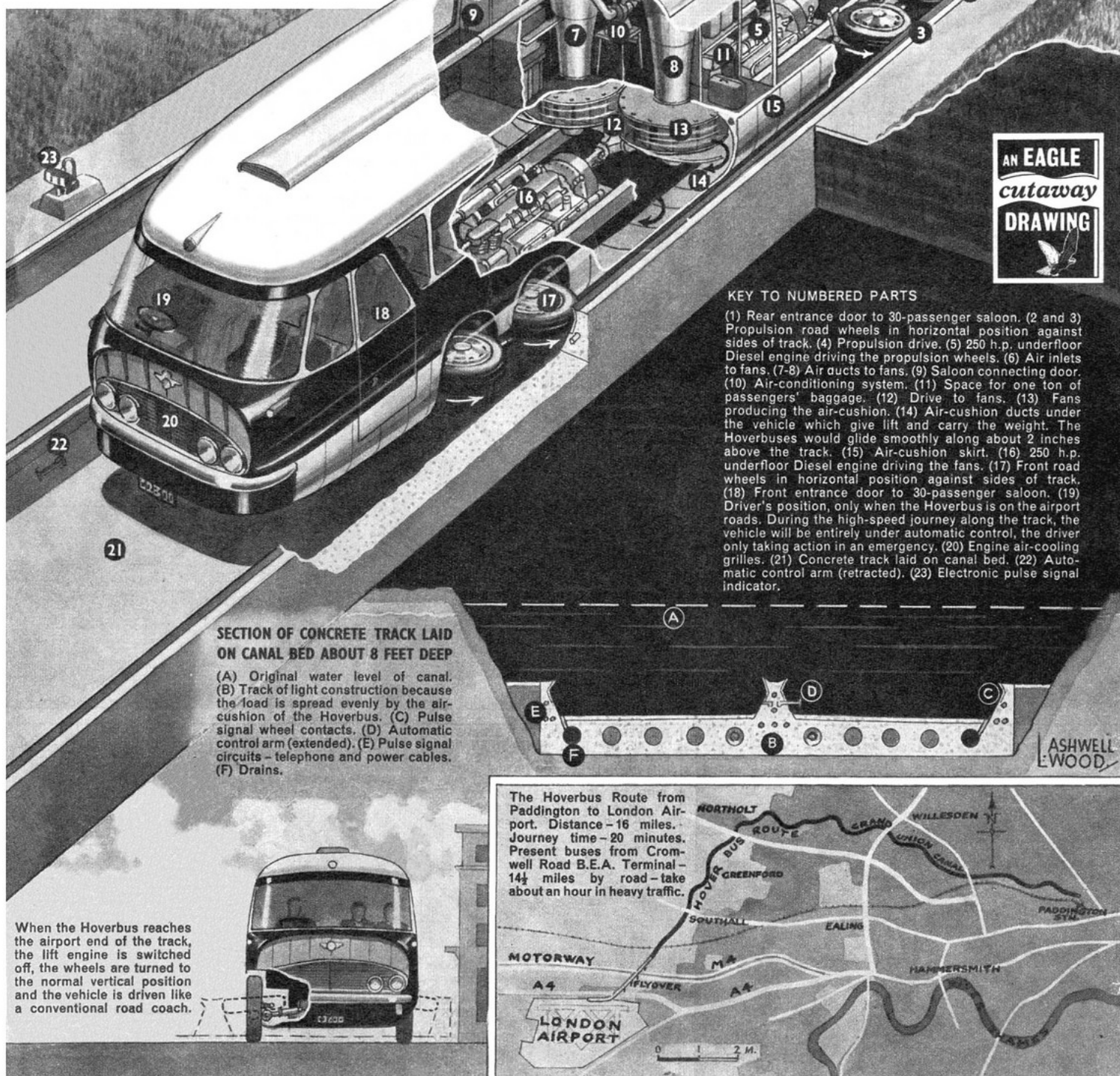


# 80 M.P.H. HOVERBUS

An 80 mile-an-hour Hoverbus service between Paddington and London Airport is proposed by a group of experts. Leading airlines and the Ministry of Transport are considering the £7 million scheme.

The route is the Paddington branch of the Grand Union Canal, now running at a loss. The Hoverbuses, riding on a cushion of air, would use concrete tracks laid on the bed of the drained canal, and guided by its road wheels extended horizontally against the sides. One of the 250 h.p. engines will drive fans to produce the air-cushion underneath the vehicle which completely carries its weight. The other 250 h.p. engine will drive the wheels which are in contact with sides of the track and thus provide forward propulsion.

The Hoverbuses would be automatically controlled by a system of electronic signalling - pulse signals fed along the track would adjust their speed so accurately that they could be operated at 40-second intervals. The journey time will be 20 minutes from Paddington to London Airport and 65 Hoverbuses could carry 4,000 passengers an hour in each direction at peak periods. A flyover at the end of the canal, over the new M4 motorway and A4 road, will take the Hoverbuses right into London Airport.



## KEY TO NUMBERED PARTS

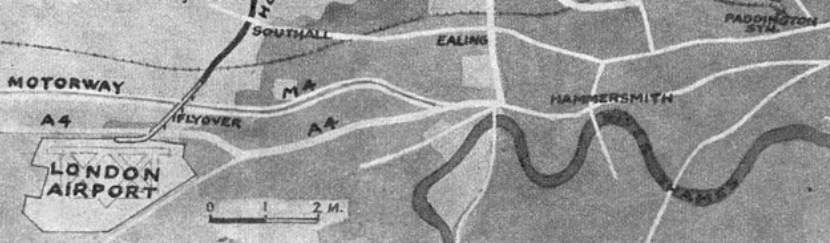
(1) Rear entrance door to 30-passenger saloon. (2 and 3) Propulsion road wheels in horizontal position against sides of track. (4) Propulsion drive. (5) 250 h.p. underfloor Diesel engine driving the propulsion wheels. (6) Air inlets to fans. (7-8) Air ducts to fans. (9) Saloon connecting door. (10) Air-conditioning system. (11) Space for one ton of passengers' baggage. (12) Drive to fans. (13) Fans producing the air-cushion. (14) Air-cushion ducts under the vehicle which give lift and carry the weight. The Hoverbuses would glide smoothly along about 2 inches above the track. (15) Air-cushion skirt. (16) 250 h.p. underfloor Diesel engine driving the fans. (17) Front road wheels in horizontal position against sides of track. (18) Front entrance door to 30-passenger saloon. (19) Driver's position, only when the Hoverbus is on the airport roads. During the high-speed journey along the track, the vehicle will be entirely under automatic control, the driver only taking action in an emergency. (20) Engine air-cooling grilles. (21) Concrete track laid on canal bed. (22) Automatic control arm (retracted). (23) Electronic pulse signal indicator.

## SECTION OF CONCRETE TRACK LAID ON CANAL BED ABOUT 8 FEET DEEP

(A) Original water level of canal. (B) Track of light construction because the load is spread evenly by the air-cushion of the Hoverbus. (C) Pulse signal wheel contacts. (D) Automatic control arm (extended). (E) Pulse signal circuits - telephone and power cables. (F) Drains.

When the Hoverbus reaches the airport end of the track, the lift engine is switched off, the wheels are turned to the normal vertical position and the vehicle is driven like a conventional road coach.

The Hoverbus Route from Paddington to London Airport. Distance - 16 miles. Journey time - 20 minutes. Present buses from Cromwell Road B.E.A. Terminal - 14½ miles by road - take about an hour in heavy traffic.





# THE NORTH AMERICAN F-86 SABRE AND THE MIG-15

These two drawings of the F-86 Sabre and MIG-15 have very clearly a similarity in general layout. Even from the aircraft recognition view-point, their general appearance is the same except for one detail - the huge fin and high-set tailplane of the MIG-15.

While the MIG-15 is an extremely good aircraft and not to be underrated, the Sabre is superior both in equipment and general manoeuvrability.

## PERFORMANCE FIGURES FOR SABRE

Maximum speed at sea level - 650 m.p.h.

Initial climb rate 8,000 feet per minute.

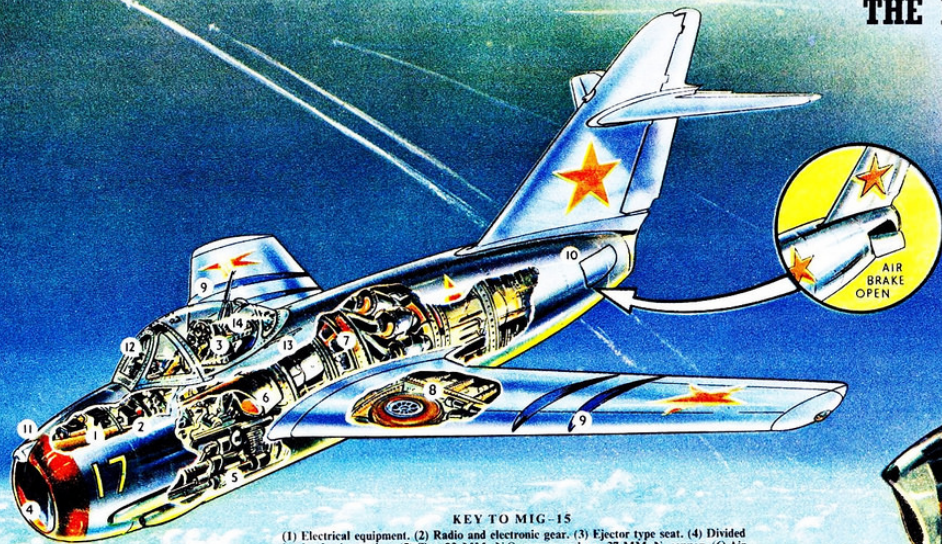
Service ceiling 52,000 feet.

## PERFORMANCE FIGURES FOR MIG-15

Maximum speed at sea level - 672 m.p.h.

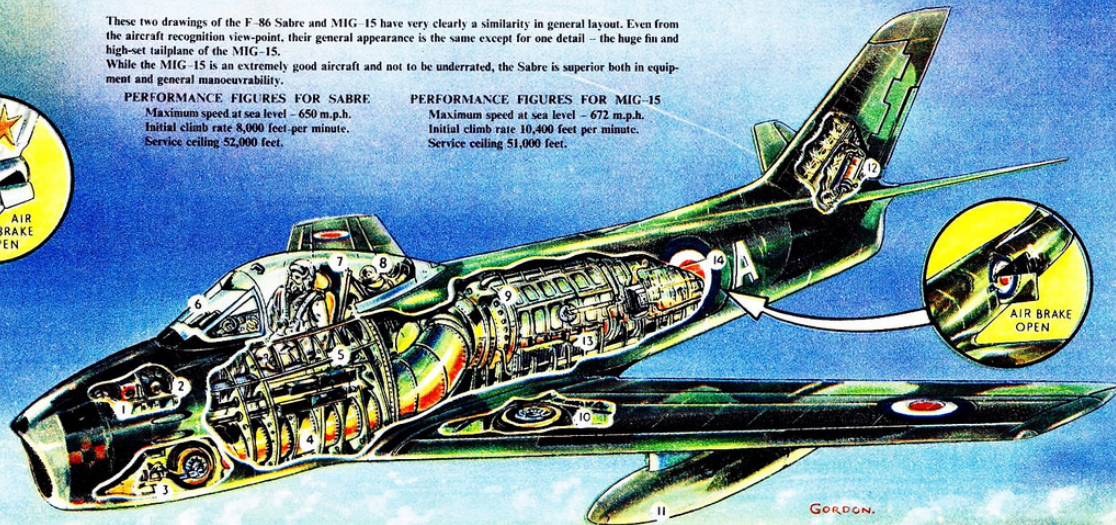
Initial climb rate 10,400 feet per minute.

Service ceiling 51,000 feet.



## KEY TO MIG-15

(1) Electrical equipment. (2) Radio and electronic gear. (3) Ejector type seat. (4) Divided intake for jet engine. (5) Two 23 MM. N.S. cannon and one 37 MM. N. cannon. (6) Air trunking to engine. (7) R.D-45 (derived from Rolls-Royce Nene) engine, developing 6,000 lb. static thrust (6,750 with water injection). (8) Main wheels retract into wing inner panels. (9) Boundary wing fences. (10) Air brake. (11) Combat camera gun. (12) Gyro-sunsight. (13) Canopy slide rails. (14) Cockpit pressurized.



## KEY TO NORTH AMERICAN SABRE F-86

(1) Radar. (2) Batteries and transmitter. (3) Nose wheel retracted. (4) Air trunk to engine. (5) 2 port 20 MM. cannon. (6) Radar gun sight (bomb, guns, and rockets). (7) North American ejector seat. (8) Cockpit pressure regulator and outlet. (9) General electric J-47 jet engine, developing over 5,800 lbs. static thrust. (10) Main wheels retracted. (11) Drop tanks each side. (12) Tailplane actuator jack. (13) Rear fuel cell. (14) Air brake.

GORDON.



# THE NEW ONE-ELEVEN

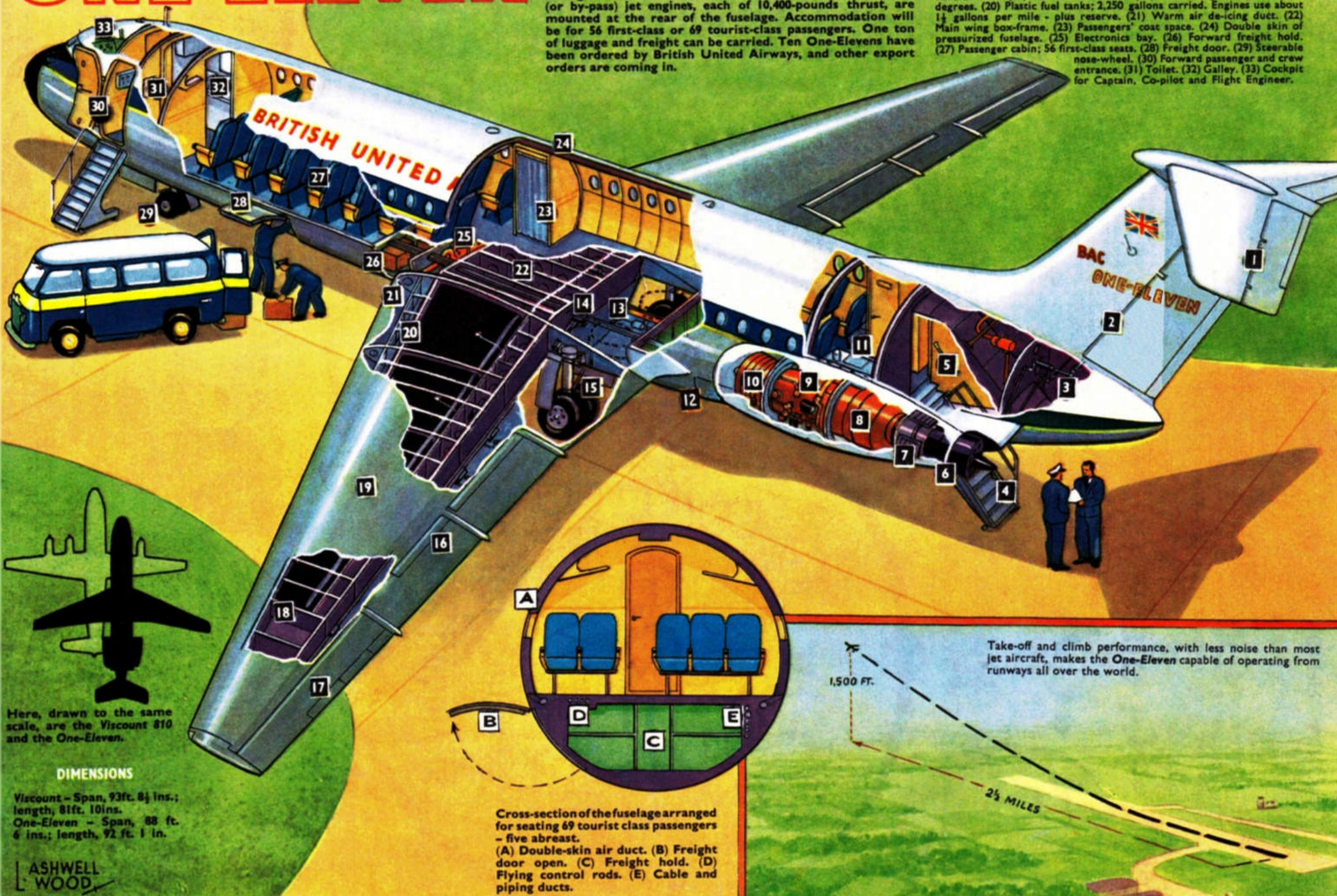
This aircraft (the Vickers 111) has been designed as the jet successor to the world-famous Vickers Viscount, nearly 500 of which have been built.

Known as the B.A.C., the British Aircraft Corporation now embodies Vickers Aircraft, British Aircraft, English Electric Aviation and Hunting Aircraft.

The One-Eleven, which will first fly towards the end of this year, is a short-haul aircraft cruising at 540 m.p.h., with a range of about 1,300 miles. Two Rolls-Royce Spey turbofan (or by-pass) jet engines, each of 10,400-pounds thrust, are mounted at the rear of the fuselage. Accommodation will be for 56 first-class or 69 tourist-class passengers. One ton of luggage and freight can be carried. Ten One-Elevens have been ordered by British United Airways, and other export orders are coming in.

## KEY TO NUMBERED PARTS

- (1) Swept-back tailplane and elevators. (2) Swept-back fin and rudder. (3) Rudder and elevator controls. (4) Retractable steps, lowered for passenger entry. (5) Rear entrance to fuselage. (6) Engine-noise suppressor. (7) Reverse thrust outlet. (8) Turbine casing. (9) Rolls-Royce Spey turbofan jet engine (port side). (10) Air entry and compressor. (11) Coffee bar and rear toilet. (12) Rear freight hold. (13) Undercarriage wheel bay. (14) Flying control rods. (15) Main undercarriage, retracts inwards. (16) Air brakes (landing flaps under). (17) Port aileron. (18) End of fuel tanks. (19) Main wings swept back 20 degrees. (20) Plastic fuel tanks; 2,250 gallons carried. Engines use about 1½ gallons per mile - plus reserve. (21) Warm air de-icing duct. (22) Main wing box-frame. (23) Passengers' coat space. (24) Double skin of pressurized fuselage. (25) Electronics bay. (26) Forward freight hold. (27) Passenger cabin; 56 first-class seats. (28) Freight door. (29) Steerable nose-wheel. (30) Forward passenger and crew entrance. (31) Toilet. (32) Galley. (33) Cockpit for Captain, Co-pilot and Flight Engineer.



Here, drawn to the same scale, are the Viscount 810 and the One-Eleven.

## DIMENSIONS

Viscount - Span, 93ft. 8½ ins.; length, 81ft. 10ins.  
One-Eleven - Span, 88 ft. 6 ins.; length, 92 ft. 1 in.

ASHWELL  
L. WOOD

Cross-section of the fuselage arranged for seating 69 tourist class passengers - five abreast.  
(A) Double-skin air duct. (B) Freight door open. (C) Freight hold. (D) Flying control rods. (E) Cable and piping ducts.

Take-off and climb performance, with less noise than most jet aircraft, makes the One-Eleven capable of operating from runways all over the world.



# The Lighter-Than-Air Hotel

By Dr LYALL WATSON

Artist's impression of one of the proposed new atomic airships as she glides across the sky-line of a great city. Cutaway sections show the internal design of the craft

roofed with a dome of plexiglass more than a hundred feet across. From here, the passengers could enjoy the luxury of dining and dancing among the clouds.

For the passengers, the whole trip would be silent and smooth. The ground would drift by some 2,000 feet below in an endless panorama, changing slowly as the ship travelled at about 100 miles per hour. On journeys over the ocean, they would be able to watch schools of fish and dolphins at play and perhaps catch sight of things which the other forms of transport are too fast or noisy ever to see.

To observers on the ground, the ships will look like 1,000-foot floating cigars, drifting silently and elegantly across the sky — no noise, no dirt, no vibration, no supersonic bangs.

## RELAXED TRAVEL

All in all, the idea seems certain of success. Who will want to spend long days on a rocking ship or short uncomfortable hours in a jet, when they can drift across the Atlantic in about 40 hours? This time is short enough to make it possible for businessmen to leave New York on Saturday evening and arrive, fresh and rested, in the middle of London at breakfast time on Monday — and a time long enough for tourists to relax and enjoy a unique view of the land and sea.

At last someone has come up with an idea that solves all the problems of travel.

Next Week:

MAN IN  
DEEP FREEZE!

world non-stop, with cargo and passengers being flown up to them in a small shuttle plane.

The Boston University plans include a trapeze which hangs down below the airship and captures the shuttle plane, then pulls it up through panels which open in the underside of the hull. The U.S. Navy has already shown that this apparatus works and, with shuttle planes operating from all the cities of the world, the giant airships could be drifting slowly around over the most interesting places in the world.

The passengers would be housed in 42,000 square feet of deck space in staterooms like the best hotel rooms with fantastic views. There would be restaurants, shops, a theatre, a cinema, and games rooms in the lower compartments.

On top of the airship, reached by a lift, there would be a 'sky room'

pace and today we find ourselves on the brink of a new supersonic passenger service provided by the Anglo-French 'Concorde'. With this it is going to be possible to cross the Atlantic in a matter of minutes. But the cost and the noise are beginning to worry many people.

Some are now thinking again about the space and the silence and the dignity of the old airships and planning a new and safer approach to them.

## UNLIMITED RANGE

Today, with new sources of power, new design and new materials, there is no reason why we should not build a lighter-than-air ship as safe as anything else in the air.

Boston University's Department of Aerospace Engineering and Goodyear Aircraft have designed one and the chances are that, in the very near future, someone is going to build it. The estimated cost is only ten million pounds for testing and building. This is a fraction of the cost of even most small fighting planes.

The new design features a nuclear power plant which would give the ship an unlimited range — it could go several times round the earth without refuelling. And the weight it would be able to support is enormous.

In addition to 400 passengers, it could carry 150 cars and deliver them to any place, anywhere in the world in a hundred hours or so at a cost of about £150 per car.

## SHUTTLE SERVICE

Mooring masts could be set up anywhere. There will be no need for the enormous runways that are necessary for the big jets. Even those remote islands, which now have no airfield because they are too small and steep, could build a mooring mast.

Masts could be built right in the centre of even the largest cities, eliminating the need for the long journey out to airports. And the airships would be completely silent, gliding slowly in and out of the cities with no more than a shadow to disturb the people living there.

Echo I, the brightest of the earth satellites and still visible to the naked eye.

So the balloon came first and then, two centuries later, the powered plane. The two existed together — each going its own way — in the first part of the 20th century. But it was not too long before some bright spark thought of joining the two principles and making a powered balloon. And so the airship was born. It enjoyed a few years of success, but then the lighter-than-air ship began to be plagued by disasters.

## BURNED OUT

The giant R-101, Britain's biggest rigid airship, crashed on her maiden voyage to India, killing her designer and most of the passengers. Her sister ship, the R-100, was dismantled as a result of the public outcry. The Italian airship Roma crashed and burned on her very first test flight. The German Hindenburg — the most luxurious and famous of the great balloons — crashed in full view of thousands of people as she came in to land at Lakehurst, New Jersey, in 1937.

These accidents were due to static electricity or a small leak setting fire to the hydrogen with which they were filled. Some of them may even have been caused by sabotage. But the net result was that public alarm and lack of funds caused all remaining plans to be shelved and the few airships still in operation were dismantled.

## QUIET DIGNITY

During the Second World War, fixed kite balloons were flown in a barrage over the cities of England as some protection against air raids. But no more passenger models were built.

The development of powered planes went ahead at a fantastic

HELIUM CELL  
PASSENGER AREA

CREW QUARTERS

PASSENGER AREA

POWER SYSTEM

CARGO

The elegant age of the airship may be about to return . . .

MAN was not meant to fly. All right — but he did it anyway, simply because man is quite unable to ignore that kind of irresistible challenge.

For centuries he tried to flap like a bird, only to find out — the hard way — that it wouldn't work. Then he began to figure out the principles of lift and designed an aerofoil to carry him off the ground.

So it was that two American brothers — Orville and Wilbur Wright — began their gliding experiments on the sand dunes at Kittyhawk in North Carolina. Later they added a petrol engine to their glider and, on 17th December, 1903, they made four flights — the longest one being a distance of 852 feet.

## SOARING HIGH

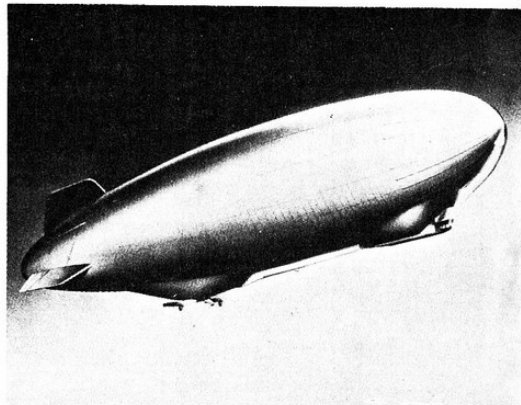
These flights were certainly the first in which man managed to leave the ground with the assistance of power, but we tend to forget that the Wright Brothers were by no means the first men to fly.

As long ago as 1783, a mad Frenchman was getting himself airborne in balloons sent up by hot air and by hydrogen. In 1862, two

Englishmen — Coxwell and Glaisher — reached a height of 7 miles. That's higher than Mount Everest. The arrival of the powered airplane stole all the glamour from the ballooners, but they continued to break new ground well into this century.

In 1931, Piccard took his balloon up to 50,000 feet — way beyond the limit of any powered plane. In 1935 the huge American balloon Explorer II, inflated with 4 million cubic feet of helium, carried a team of scientists and their floating laboratory up to a height of 74,000 feet. And in 1957, a pressurized balloon carrying an American doctor rose 90,000 feet above the earth.

In fact, a balloon — though it is unmanned — is now one of the highest things of all. One thousand miles up there is a balloon satellite as big as a ten-storey building —



A model of a 540-foot-long nuclear-powered airship designed in the U.S.A. in 1959 but never built. She was to have flown at an altitude of 10,000 feet, at a speed of 70 to 80 knots, with an almost unlimited range



The spectacular and tragic end of the great HINDENBURG as she crashed at Lakehurst, New Jersey, 1937. The crash of the HINDENBURG was one of a series of balloon disasters in the 'thirties



# WORLD'S LARGEST JET BOMBER

## BOEING B-52C STRATOFORTRESS

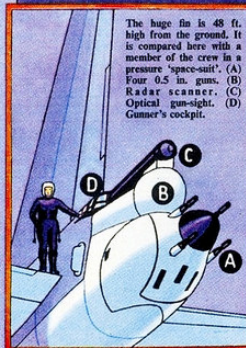
Built by Boeing at Seattle, U.S.A., these flying monsters have a fully-loaded weight of no less than 181 tons, and a top speed of 650 m.p.h. The huge swept-back wings have a span of 185 ft., under which are suspended in 'pods' the eight Pratt and Whitney J-57 turbojet engines of 12,800 pound thrust each; also, under each wing tip, there are drop fuel-tanks of 1,250 gallons each. With the wing and fuselage tanks, the total fuel capacity is 30,000 gallons, giving the aircraft a range of 6,000 miles. Three of these bombers flew round the world non-stop - a distance of 24,325 miles - being refuelled in flight five times. Each aircraft costs about £3,000,000.

A special capsule (or belly portion) containing cameras and electronic equipment can be fitted into the bomb bay for reconnaissance duties. Normal crew of six, plus two in the capsule; all have ejection seats, some downwards and some upwards.

### KEY TO FEATURES

(1) Starboard wing tip drop fuel-tank - 1,250 gallons. (2) Retracting wing tip protection wheel (when landing). (3) Outer starboard flap (down). (4) Outer starboard Pratt and Whitney J-57 turbojet engines. (5) Swept-back starboard wing. (6) Aileron. (7) Inner starboard flap (down). (8) Inner starboard turbojet engines. (9) Nylon bag type fuel-tanks in wing. (10) Radar scanner. (11) Captain and co-pilot; upward ejection seats. (12) Flight-refuelling doors in roof. (13) Radar and electronics observer on top deck; upward ejection seats. (14) Navigator and bombardier on lower deck. (15) Downward ejection hatches. (16) Galley. (17) Turbo-alternators. (18) Aerials and radar-dome. (19) Nylon fuel-tanks in forward fuselage. (20) Undercarriage retraction jacks. (21) Port undercarriage truck (retracts forwards). (22) Starboard undercarriage truck (retracts rearwards). (23) Undercarriage doors (open). (24) Reconnaissance capsule fitted into the bomb bay. (25) Electronics crew. (26) Downward ejection hatches. (27) Four cameras. (28) Nylon fuel-tanks in rear fuselage. (29)-(30) Rear undercarriage trucks. These retract in similar manner to the front ones. (31) Large fin and rudder. (32) Swept-back tail-plane and elevators. (33) Rear gunner. (34) Rear gun-turret, with four 0.5 in. machine-guns.

The huge fin is 48 ft. high from the ground. It is compared here with a member of the crew in a pressure 'space-suit'. (A) Four 0.5 in. guns. (B) Radar scanner. (C) Optical gun-sight. (D) Gunner's cockpit.



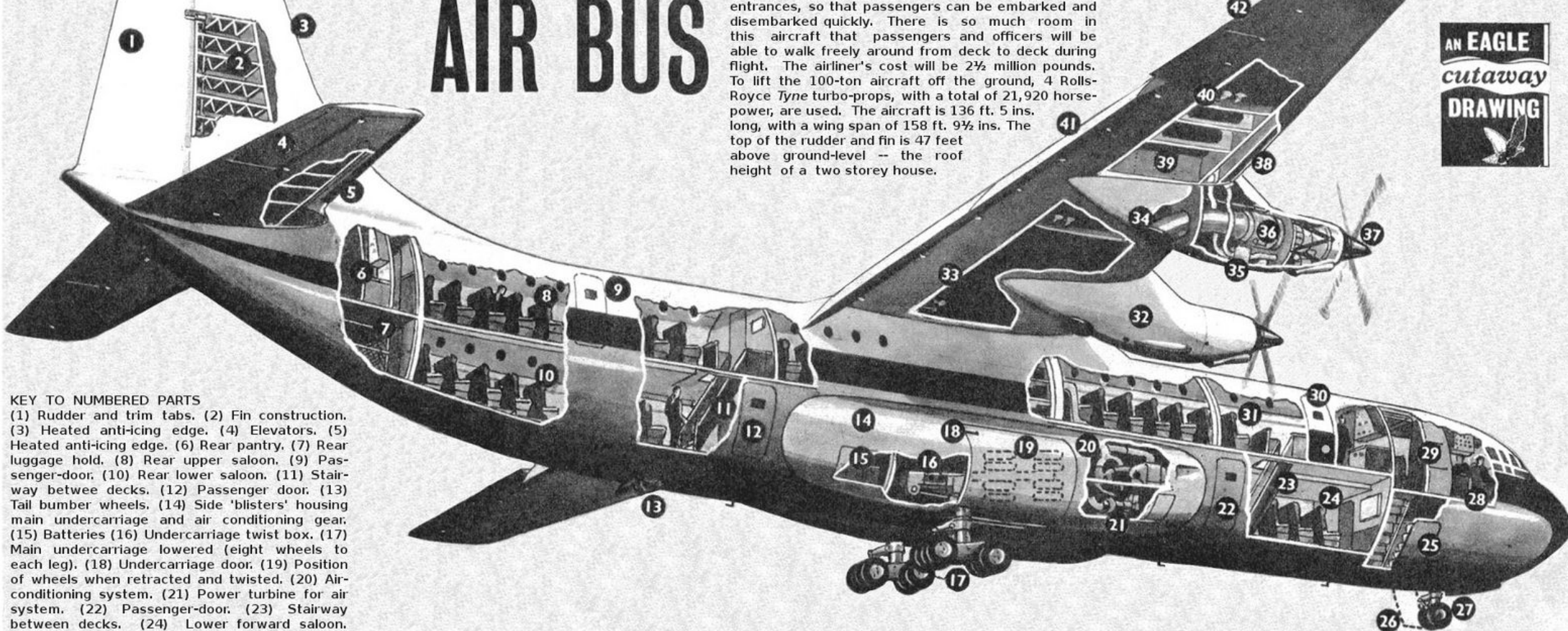


# DOUBLE-DECKER AIR BUS

Short Brothers Ltd. have produced plans for a double-decker air bus. A version of their giant Belfast freighter, it would carry 288 passengers and has been designated for B.E.A.'s short, high-density routes. It would drop passengers in Paris within an hour of leaving London. The new monster would cruise at 360 m.p.h. and land on runways only 2,000 yards long.

The new plans provide for 4 cabins and 4 separate entrances, so that passengers can be embarked and disembarked quickly. There is so much room in this aircraft that passengers and officers will be able to walk freely around from deck to deck during flight. The airliner's cost will be 2½ million pounds. To lift the 100-ton aircraft off the ground, 4 Rolls-Royce Tyne turbo-props, with a total of 21,920 horsepower, are used. The aircraft is 136 ft. 5 ins. long, with a wing span of 158 ft. 9½ ins. The top of the rudder and fin is 47 feet above ground-level -- the roof height of a two storey house.

AN EAGLE  
cutaway  
DRAWING



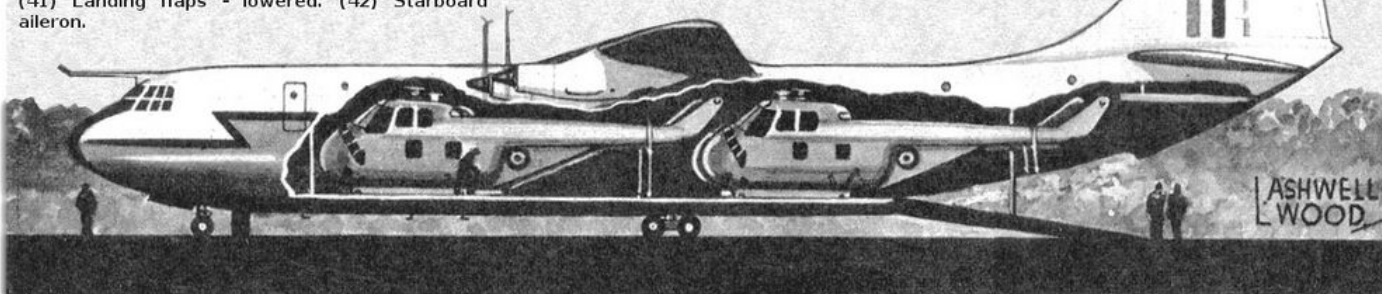
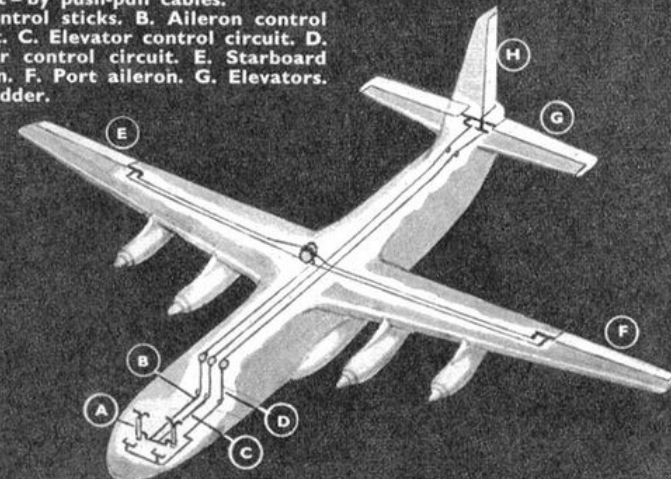
## KEY TO NUMBERED PARTS

(1) Rudder and trim tabs. (2) Fin construction. (3) Heated anti-icing edge. (4) Elevators. (5) Heated anti-icing edge. (6) Rear pantry. (7) Rear luggage hold. (8) Rear upper saloon. (9) Passenger-door. (10) Rear lower saloon. (11) Stairway between decks. (12) Passenger door. (13) Tail bumper wheels. (14) Side 'blisters' housing main undercarriage and air conditioning gear. (15) Batteries (16) Undercarriage twist box. (17) Main undercarriage lowered (eight wheels to each leg). (18) Undercarriage door. (19) Position of wheels when retracted and twisted. (20) Air-conditioning system. (21) Power turbine for air system. (22) Passenger-door. (23) Stairway between decks. (24) Lower forward saloon. (25) Crew entrance door. (26) Position of crew door when lowered to ground. (27) Steerable nose wheels-lowered. (28) Crew space for pilot, co-pilot, navigator and engineer. (29) Radio racks. (30) Passenger-door. (31) Forward upper saloon. (32) Forward starboard Rolls-Royce Tyne turbo-prop engine (33) No. 2 fuel tanks. (34) Jet exhaust pipe. (35) Wing anti-icing heat exchanger. (36) Outer starboard Rolls-Royce Tyne turbo-prop engine. Each of the four engines is rated at 5,730 horse-power. (37) 16ft.-diameter propellers. (38) Wing anti-icing edge. (39) Space for fuel tank No. 2 (40) No. 3 fuel tank - 10,090 gallons of fuel are carried, half in each wing. (41) Landing flaps - lowered. (42) Starboard aileron.

In the R.A.F. version of the Belfast freighter, four Westland Whirlwind Mk. 10 helicopters can be carried in the hold. Each helicopter is 42 feet 4 inches long without rotor blades. Other loads include tanks, trucks, aircraft refuellers or 150 fully-equipped troops.

## Simplified flying control layout of the Belfast - by push-pull cables.

A. Control sticks. B. Aileron control circuit. C. Elevator control circuit. D. Rudder control circuit. E. Starboard aileron. F. Port aileron. G. Elevators. H. Rudder.





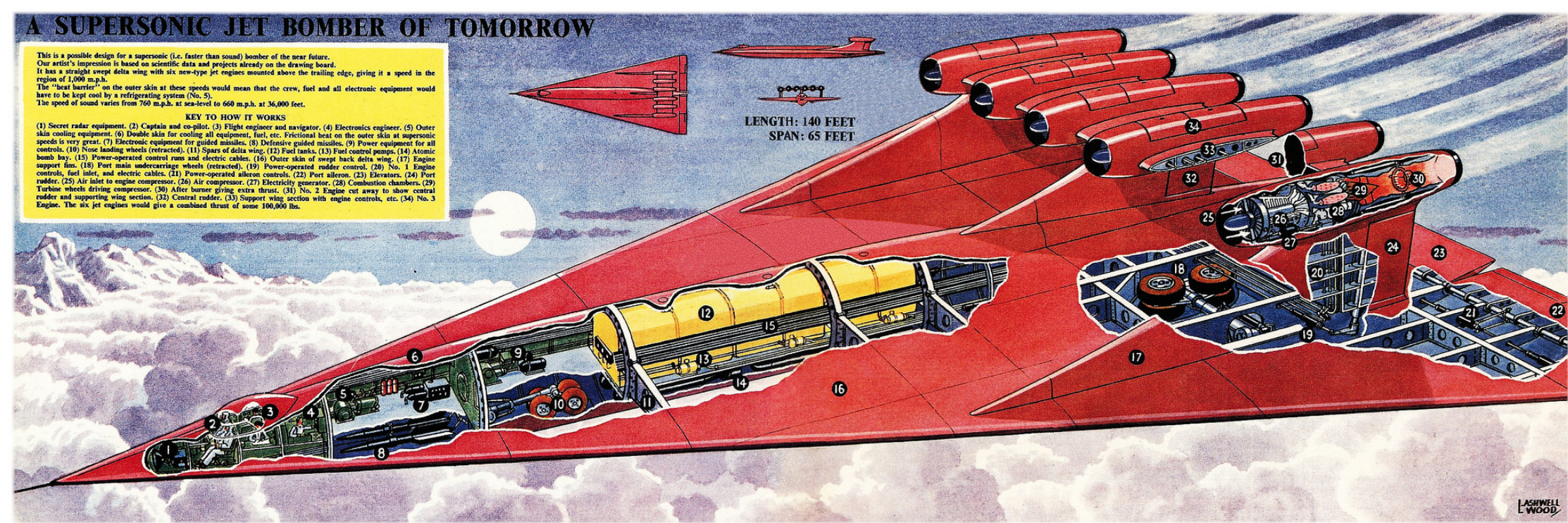
# A SUPERSONIC JET BOMBER OF TOMORROW

This is a possible design for a supersonic (i.e. faster than sound) bomber of the near future. Our artist's impression is based on scientific data and projects already on the drawing board. It has a straight swept delta wing with six new-type jet engines mounted above the trailing edge, giving it a speed in the region of 1,000 m.p.h. The "heat barrier" on the outer skin at these speeds would mean that the crew, fuel and all electronic equipment would have to be kept cool by a refrigerating system (No. 5). The speed of sound varies from 760 m.p.h. at sea-level to 660 m.p.h. at 36,000 feet.

## KEY TO HOW IT WORKS

(1) Secret radar equipment. (2) Captain and co-pilot. (3) Flight engineer and navigator. (4) Electronics engineer. (5) Outer skin cooling equipment. (6) Double skin for cooling all equipment, fuel, etc. Frictional heat on the outer skin at supersonic speeds is very great. (7) Electronic equipment for guided missiles. (8) Defensive guided missiles. (9) Power equipment for all controls. (10) Nose landing wheels (retracted). (11) Spars of delta wing. (12) Fuel tanks. (13) Fuel control pumps. (14) Atomic bomb bay. (15) Power-operated control runs and electric cables. (16) Outer skin of swept back delta wing. (17) Engine support fins. (18) Port main undercarriage wheels (retracted). (19) Power-operated rudder control. (20) No. 1 Engine controls, fuel inlet, and electric cables. (21) Power-operated aileron controls. (22) Port aileron. (23) Elevators. (24) Port rudder. (25) Air inlet to engine compressor. (26) Air compressor. (27) Electricity generator. (28) Combustion chambers. (29) Turbine wheels driving compressor. (30) After burner giving extra thrust. (31) No. 2 Engine cut away to show central rudder and supporting wing section. (32) Central rudder. (33) Support wing section with engine controls, etc. (34) No. 3 Engine. The six jet engines would give a combined thrust of some 100,000 lbs.

LENGTH: 140 FEET  
SPAN: 65 FEET





# Wellington

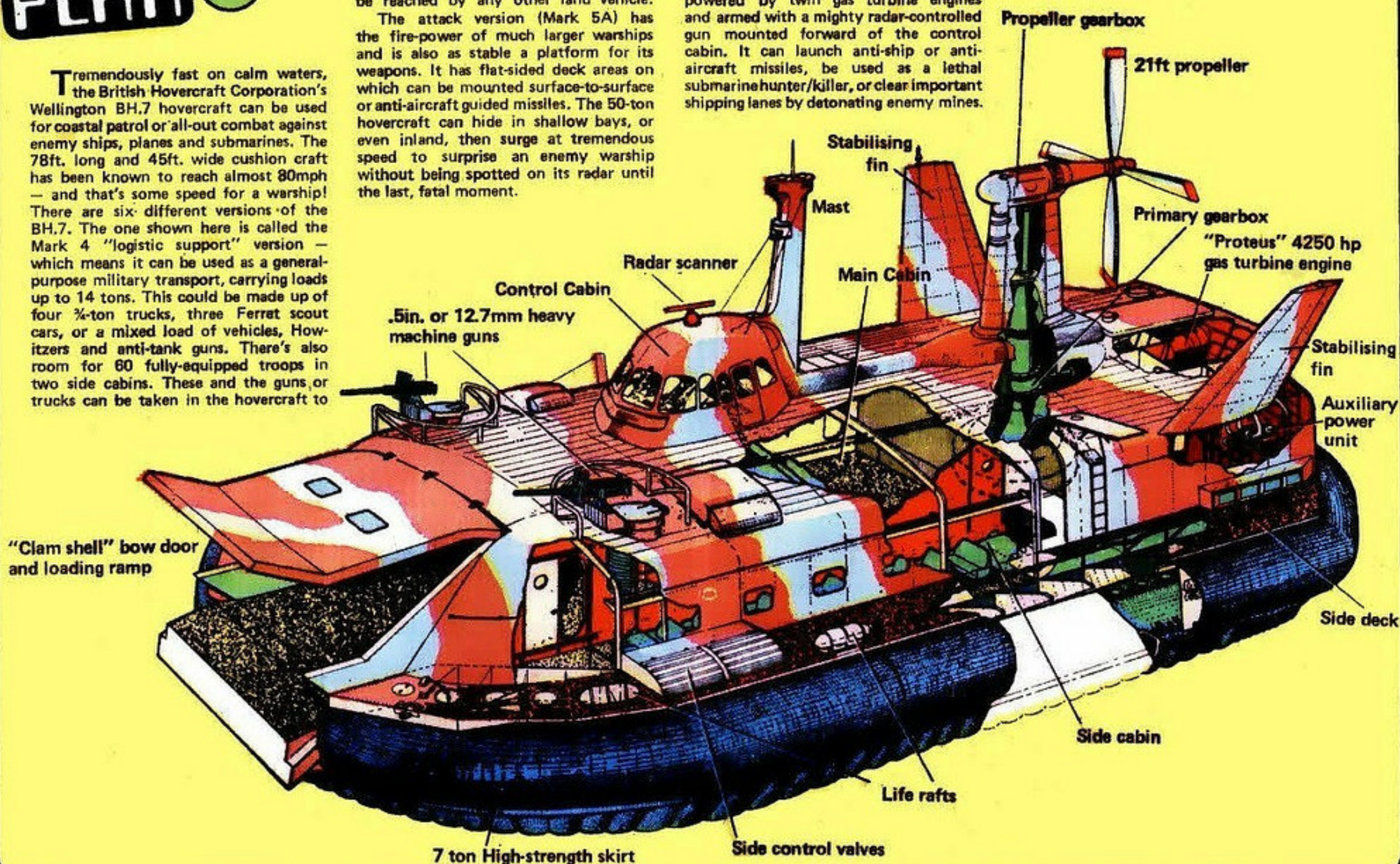
## HOVERCRAFT

Tremendously fast on calm waters, the British Hovercraft Corporation's Wellington BH.7 hovercraft can be used for coastal patrol or all-out combat against enemy ships, planes and submarines. The 78ft. long and 45ft. wide cushion craft has been known to reach almost 80mph — and that's some speed for a warship! There are six different versions of the BH.7. The one shown here is called the Mark 4 "logistic support" version — which means it can be used as a general-purpose military transport, carrying loads up to 14 tons. This could be made up of four  $\frac{3}{4}$ -ton trucks, three Ferret scout cars, or a mixed load of vehicles, Howitzers and anti-tank guns. There's also room for 60 fully-equipped troops in two side cabins. These and the guns, or trucks can be taken in the hovercraft to

beaches or inland areas which, because of their remoteness or obstacles, cannot be reached by any other land vehicle.

The attack version (Mark 5A) has the fire-power of much larger warships and is also as stable a platform for its weapons. It has flat-sided deck areas on which can be mounted surface-to-surface or anti-aircraft guided missiles. The 50-ton hovercraft can hide in shallow bays, or even inland, then surge at tremendous speed to surprise an enemy warship without being spotted on its radar until the last, fatal moment.

There is a bigger version, the 90-ton combat/patrol Mark 6 — 108ft. long, powered by twin gas turbine engines and armed with a mighty radar-controlled gun mounted forward of the control cabin. It can launch anti-ship or anti-aircraft missiles, be used as a lethal submarine hunter/killer, or clear important shipping lanes by detonating enemy mines.





# WORLD'S LARGEST FLYING CRANE

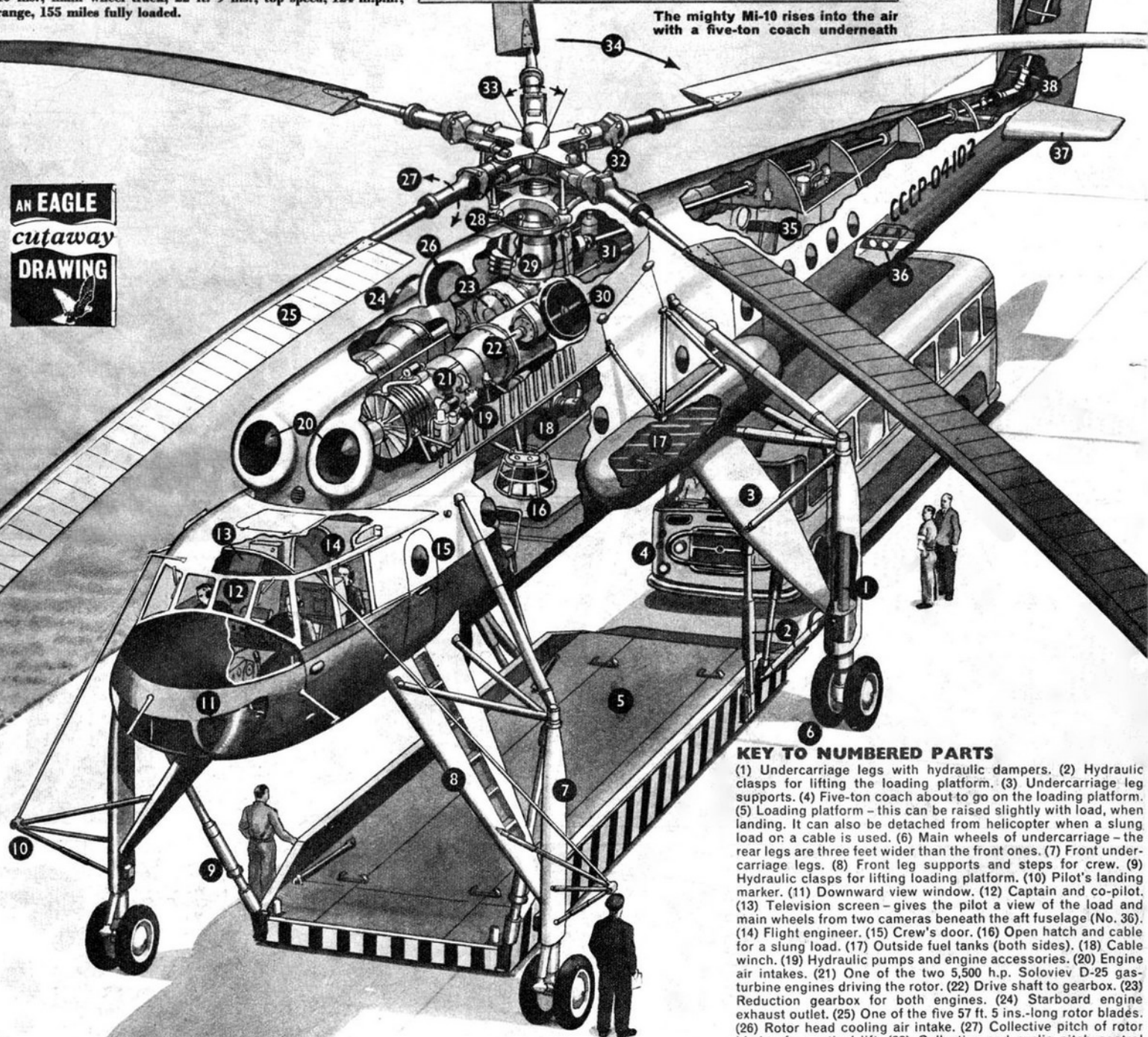
Looking like a giant flying spider with two huge 'eyes' and crouching on its legs waiting to take off, the largest helicopter in the world might be likened to something out of this world. But it is a reality - Russia's Mi-10 flying crane, the 'eyes' being air intakes for the two 5,500 h.p. gas-turbine engines which drive the huge rotor blades.

It can lift a London bus or a tank on a platform carried under its belly, and its legs can straddle a 25-ton load measuring up to 66 ft. by 20 ft. by 11 ft. by means of hydraulic clamps on the undercarriage legs. Bulkier but lighter loads can be slung on a cable hanging down between the legs. As a passenger-carrier, the Mi-10 can be equipped with 80 seats. The Russians hope this giant helicopter will be most useful on heavy engineering construction work like motorways, bridges, power stations, docks, oil drilling and so forth.

Specifications: Length, 107 ft. 10 ins.; rotor diameter, 114 ft. 10 ins.; main wheel track, 22 ft. 9 ins.; top speed, 124 m.p.h.; range, 155 miles fully loaded.



The mighty Mi-10 rises into the air with a five-ton coach underneath



## KEY TO NUMBERED PARTS

- (1) Undercarriage legs with hydraulic dampers. (2) Hydraulic clamps for lifting the loading platform. (3) Undercarriage leg supports. (4) Five-ton coach about to go on the loading platform. (5) Loading platform - this can be raised slightly with load, when landing. It can also be detached from helicopter when a slung load or a cable is used. (6) Main wheels of undercarriage - the rear legs are three feet wider than the front ones. (7) Front undercarriage legs. (8) Front leg supports and steps for crew. (9) Hydraulic clamps for lifting loading platform. (10) Pilot's landing marker. (11) Downward view window. (12) Captain and co-pilot. (13) Television screen - gives the pilot a view of the load and main wheels from two cameras beneath the aft fuselage (No. 36). (14) Flight engineer. (15) Crew's door. (16) Open hatch and cable for a slung load. (17) Outside fuel tanks (both sides). (18) Cable winch. (19) Hydraulic pumps and engine accessories. (20) Engine air intakes. (21) One of the two 5,500 h.p. Soloviev D-25 gas-turbine engines driving the rotor. (22) Drive shaft to gearbox. (23) Reduction gearbox for both engines. (24) Starboard engine exhaust outlet. (25) One of the five 57 ft. 5 ins.-long rotor blades. (26) Rotor head cooling air intake. (27) Collective pitch of rotor blades for vertical lift. (28) Collective and cyclic pitch control rods. (29) Rotor drive. (30) Port engine exhaust outlet. (31) Tail rotor drive shaft. (32) Rotor blade pitch joints. (33) Tilt of the rotor head - cyclic pitch. This gives forward, backward or sideways flight. (34) Direction of rotation. (35) Passenger cabin - 28 seats. (36) Television cameras - screen in pilot's cockpit. (37) Tilting stabilizing fins. (38) Intermediate gearbox for tail rotor drive. (39) Tail rotor gearbox. (40) Tail rotor. This acts as a rudder for directional control - left or right according to the pitch of the blades.



# THE SKYCRANE

**I**N 1959, the U.S. Navy asked Sikorsky Helicopters Ltd. to design a helicopter for use as a heavy assault machine capable of placing 68 fully-armed troops on a beach, of carrying 48 stretchers and crew of medical staff or 55 passengers. A short time later, with Sikorsky and the Navy sharing the cost, the first Skycrane, code-named the S.60, was born. Development has gone ahead so well that the latest product, the S.64, will be built under license by **Weser Flugzeugbau** of Bremen, Germany, if the German forces decide to order the craft.

At present, the S.64 Skycrane can lift a 10-ton load and fly it 190 miles at a speed of anything from 100-165 m.p.h. -- depending on the air drag caused by the load. Maximum range is achieved at an economical cruising speed of 110 m.p.h. Its rate of climb is 1,400 feet per minute. With an empty weight of about 7½ tons the ability to lift such a load is excellent.

A great variety of loads can be carried, but best results came from the special containers built for the aircraft. Guns or six jeeps or heavy trucks (up to 10 tons in weight) are all useful loads in the armed forces. On the civilian side, 55 passengers in airline comfort can be transported. At present the S.65, an all-passenger machine, is being designed. This will have a streamlined fuselage more on the lines of a conventional airliner as opposed to the pod and boom arrangement on the S.63.

The U.S. Marines will have their own type, designated C.H. - 53A, which will also float, have rear loading provision and stabilizing sponsors containing retractable undercarriage and fuel.

All in all, this is a very useful machine with a wide range of uses in this country as well as the U.S.A. and Germany.

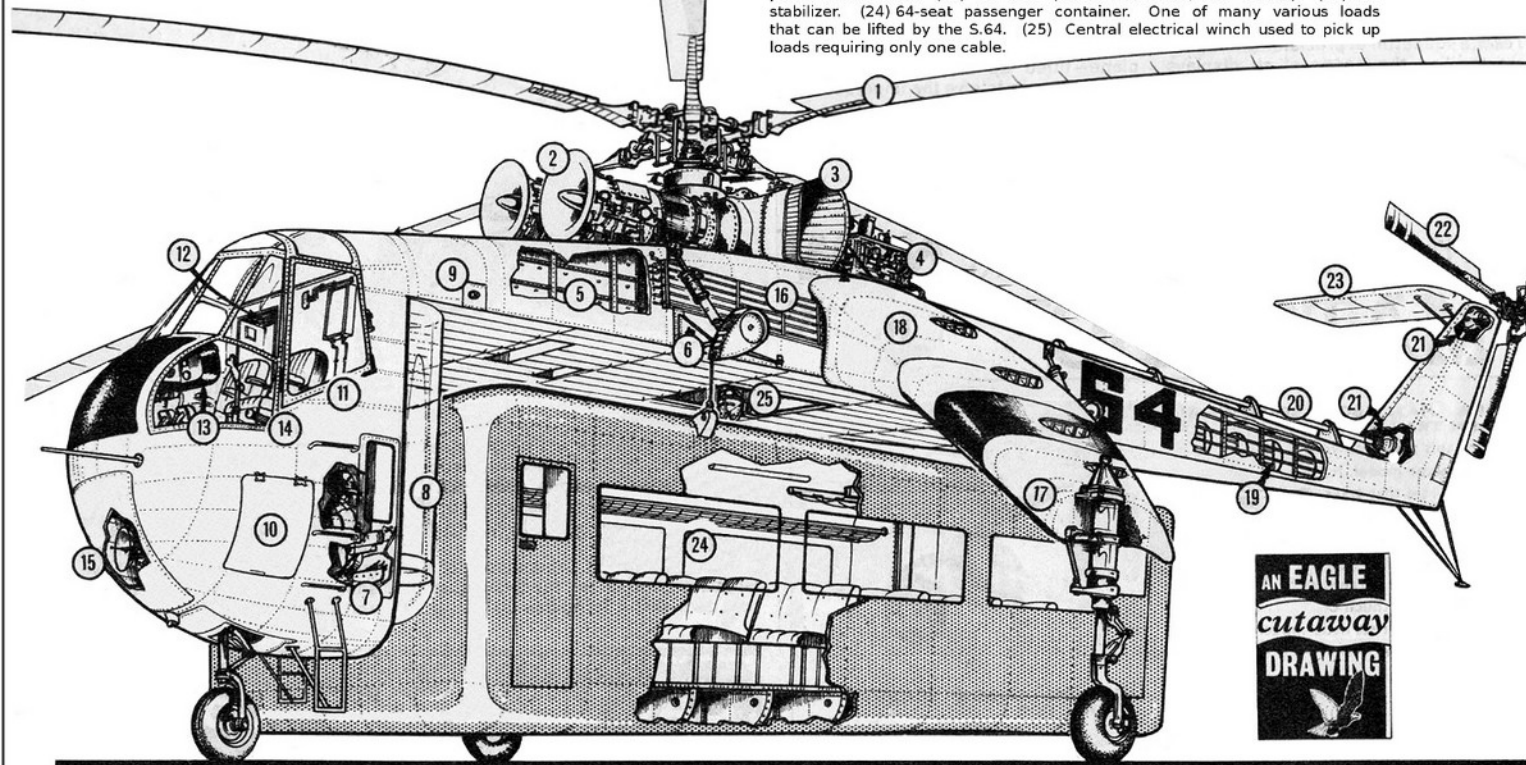
## KEY TO NUMBERED PARTS

(1) 6-blade main rotor; overall diameter 72 feet. (2) Two Pratt and Whitney shaft drive jet engines developing 4,050 h.p. each. (3) Engine exhaust (one either side). (4) Engine and rotor head electrics. (5) Flexible fireproof fuel tanks. (6) One of the four electrical hoists on which the various loads are suspended. (7) Co-pilot, who operates the press-button controls lowering and raising the cargo. He also operates the controls which make the machine 'kneel'. (Details below). (8) Glass bay window used by co-pilot



## An S.64 Skycrane carrying a 'Flexible Tanker' of petrol

during loading and unloading. (9) Port navigation light. (10) Radio bay. (11) Entrance to cockpit. (Port and Starboard). (12) Way down to cargo control seat. (13) Instrument console. (14) Landing 'down view' window. (15) All-weather flying radar scanner. (16) Oil cooler pipes. (17) Mechanics walk-way steps. (18) Complicated undercarriage leg which bends to allow machine to kneel. Method is still on the secret list. (19) Conventional aircraft structure in boom. (20) Tail rotor drive shaft. (21) Gearboxes taking power to tail rotor. (22) Tail rotor (15 feet diameter, four blades). (23) Tail stabilizer. (24) 64-seat passenger container. One of many various loads that can be lifted by the S.64. (25) Central electrical winch used to pick up loads requiring only one cable.



## HOW IT 'KNEELS'

Instead of the S.64 having to take off from the spot where it picks its load up, provision has been made for it to 'kneel', pick up its load and then taxi out to the take-off area. The drawings show what happens. The load is pushed under the fuselage (Fig. 1), where it is positioned. Fig. 2 shows how it does a 'knees bend'. The load is then attached and the helicopter straightens itself (Fig. 3). This ingenious mechanism is unfortunately still on the secret list, but its usefulness can be quickly seen. It can be assumed that an electrical supply, either from the ground or from the helicopter engines, drives hydraulic pumps to make this 'kneeling' operation possible.

J.H. Batchelor

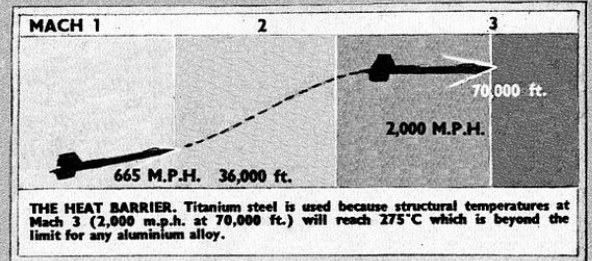


# WORLD'S FASTEST FIGHTER-BOMBER DESTROYER

Called the A-11, the new American secret supersonic jet fighter can fly at 2,000 m.p.h. at 70,000 ft. This far exceeds the performance of any other service aircraft in the world. The Lockheed A-11 is constructed largely of titanium, necessary to withstand the terrific temperatures of the air. Armament and performance figures are a secret, but the aircraft are said to have a long range.

The two power units mounted at the rear of the 'double-delta' wings are Pratt and Whitney J.58 turbojets of 30,000 lb. static thrust each.

Unusual features are the all moving fin-rudders, two ventral fins, one beneath each engine nacelle, and a large stabilizing ventral fin beneath the rear of the fuselage. This folds sideways for clearance during take-off and landing.



## KEY TO NUMBERED PARTS:

(1) Hughes' fire-control radar. (2) Pilot in thermal-protective clothing. (3) Second crew member. (4) Electronics bay. (5) Nose wheels retracted. (6) First portion of 'double-delta' wing. (7) Central fuel tanks. (8) Control runs. (9) Air-to air guided missile bays. (10) Wing fuel tanks (port and starboard). (11) Engine air intakes. (12) Intake air control doors to starboard Pratt and Whitney J.58 turbojet engine. (13) Wing cross-section for engine mounting. (14) Main undercarriage retracted. (15) Wing fuel tanks (port and starboard). (16) Movable fin-rudder control. (17) All moving fin-rudder. (18) Starboard aileron. (19) Variable jet-nozzle exhaust opening. (20) Flying controls. (21) Elevators. (22) Folding ventral stabilizing fin. (23) Port aileron. (24) Trim tab. (25) All-moving fin-rudder. (26) Variable jet nozzle exhaust opening. (27) Re-heat chamber. (28) Second portion of 'double-delta' wing. (29) Combustion chamber of port Pratt and Whitney J.58 turbojet engine. (30) Engine air compressors. (31) Cone and wedge engine air intake (prevents air congestion at supersonic speeds).

## THE SECRET NEEDLE

The U.S. Air Force Lockheed A-11 Fighter-Bomber Destroyer. Length, 110 ft. Speed, 2,000 m.p.h. at 70,000 ft. The rear ventral fin is shown folded sideways.



ASHWELL  
WOOD

# NEXT WEEK: THE 80 M.P.H. HOVERCRAFT!



# Pegasus

## HYDROFOIL

Now undergoing sea trials off the United States eastern coastline is Pegasus, the first of a new class of superfast, hard-hitting hydrofoil warships planned for the United States Navy. Officially called Patrol Hydrofoil Missile ships (PHMs), the Pegasus-class vessels are designed for hit-and-run duty in coastal waters such as those in the Baltic, the Red Sea and Persian Gulf. It is reckoned that they will be able to top 50 knots (57 mph) and fire Harpoon surface-to-surface missiles which are capable of sinking even the largest enemy warship. That's some firepower for a vessel only 121 feet long, 23 feet wide and carrying a crew of just 21 specialist officers and seamen!

There are several other ways in which Pegasus and her sister ships will be special. Being hydrofoils, they ride high on two automatically

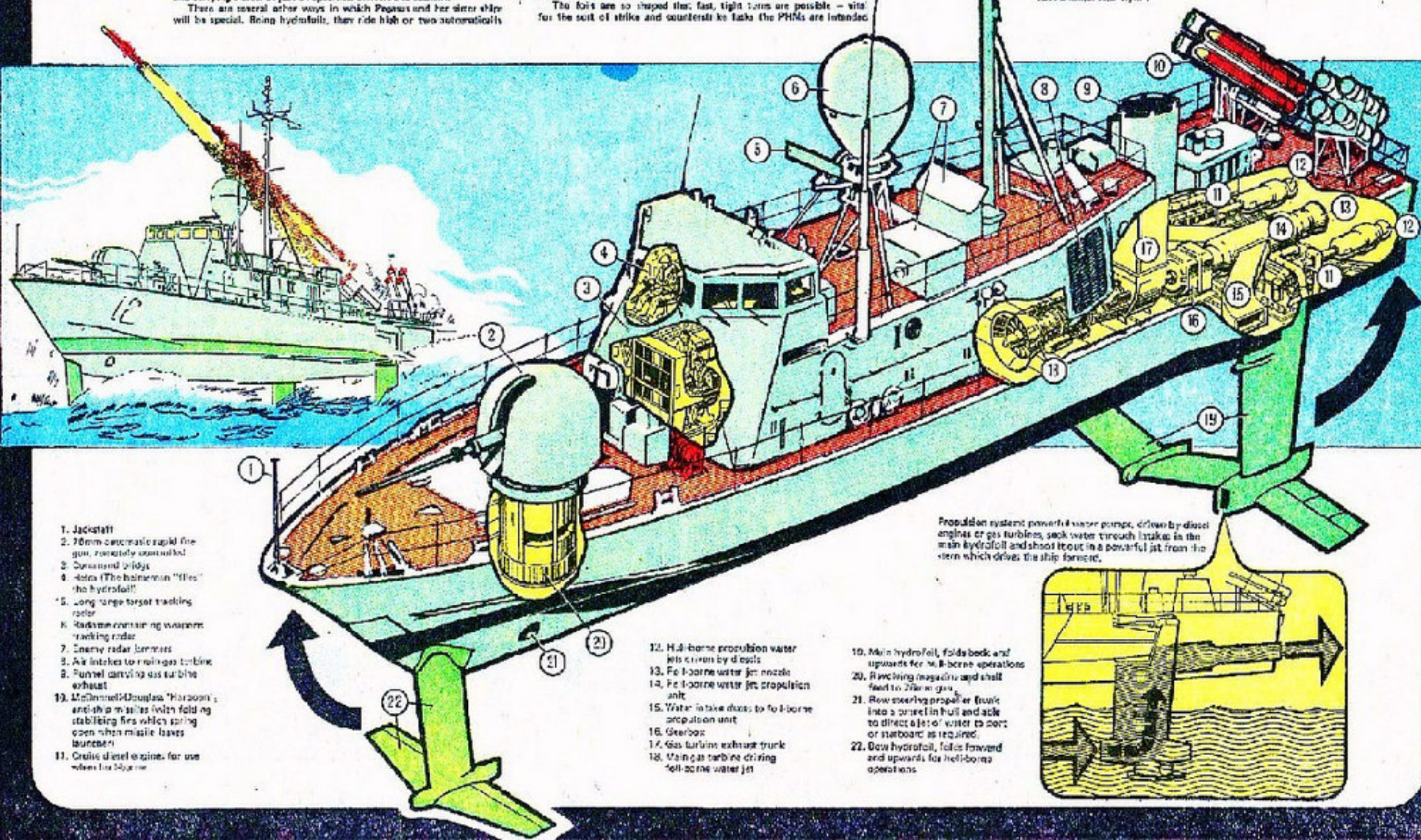
operated foils, one at the bow and the main one at the stern. Both foils can be folded up so that when stationary the PHMs float on their hulls and look similar to the normal fast patrol boats. But as they gather speed they rise up on to the foils so smoothly that the "lift-off" is hardly noticeable aboard, except for the fact that the vessels can almost fly through the wavetops. Power comes from waterjet pumps mounted in the rear foil and driven by gas turbine and diesel engines. Water is sucked into the jets through intakes at the front of the foil then squirted out at fantastic but controllable force above the ocean surface.

The foils are so shaped that fast, tight turns are possible — vital for the sort of strike and counterstrike tasks the PHMs are intended

for. And often the vessels will need to stop in a hurry; to do this the dipper merely drops the hull on to the water — in two seconds flat!

Besides the devastating anti-ship missiles, each Pegasus-class hydrofoil ship will be armed with an Italian-made 76 mm rapid-fire gun on her bow. Automatically controlled, this can be used against enemy warships and coastal defences.

The company which is building the Pegasus PHMs is Boeing, who produced the giant 747 Jumbo jet passenger aircraft and many other planes, including massive bombers. It looks as though they have another real "flyer"!

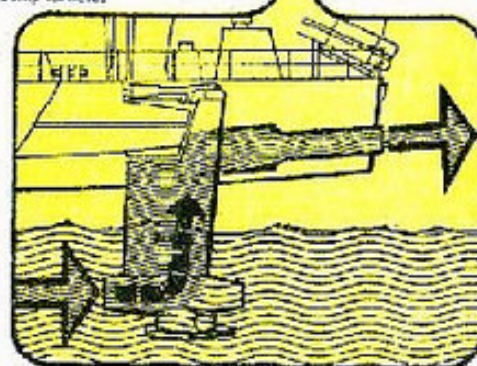


1. Mast
2. 76mm automatic rapid fire gun, remotely controlled
3. Gun turret
4. Radar
5. Long range target tracking radar
6. Radar containing weapons tracking radar
7. Enemy radar bearings
8. Air intakes to main gas turbine
9. Funnel carrying gas turbine exhaust
10. McDonnell Douglas "Harpoon" anti-ship missiles (with folding stabilising fins which spring open when missile leaves launcher)
11. Cruise diesel engines for use when in drydock

12. Hull-borne propulsion water jets driven by diesels
13. Foil-borne water jet nozzle
14. Foil-borne water jet propulsion unit
15. Water intake ducts to foil-borne propulsion unit
16. Gearbox
17. Gas turbine exhaust trunk
18. Main gas turbine driving foil-borne water jet

19. Main hydrofoil, folds back and upwards for hull-borne operations
20. Raising magazine and shell feed to 76mm gun
21. Bow steering propeller trunk into a tunnel in hull and able to direct a jet of water to port or starboard as required
22. Bow hydrofoil, folds forward and upwards for hull-borne operations

Propulsion system: powerful water pumps, driven by diesel engines or gas turbines, suck water through intakes in the main hydrofoil and shoot it out in a powerful jet from the stern which drives the ship forward.





# THE FAIREY ROTODYNE

The Fairey Rotodyne, a prototype of which is now being constructed for the Ministry of Supply, is a most unusual aircraft, in that it is designed to have the flying advantages of the helicopter, autogyro and the ordinary type of aeroplane.

The sequence of a flight will be as follows. The engines will be started, and will deliver compressed air to the pressure jets at the rotor tips. When these are on the move, fuel is ignited in the jets which will speed them up and the machine will rise vertically like a helicopter.

Once in the air, power will gradually be transferred from the pressure jets, to the airscrews. The aircraft will then move forward and the rotors will auto-rotate, i.e. turn on their own account, because of the forward passage of the machine through the air.

When about to land, the power will again be transferred to the rotors and the pressure jets ignited. The machine will then descend vertically.

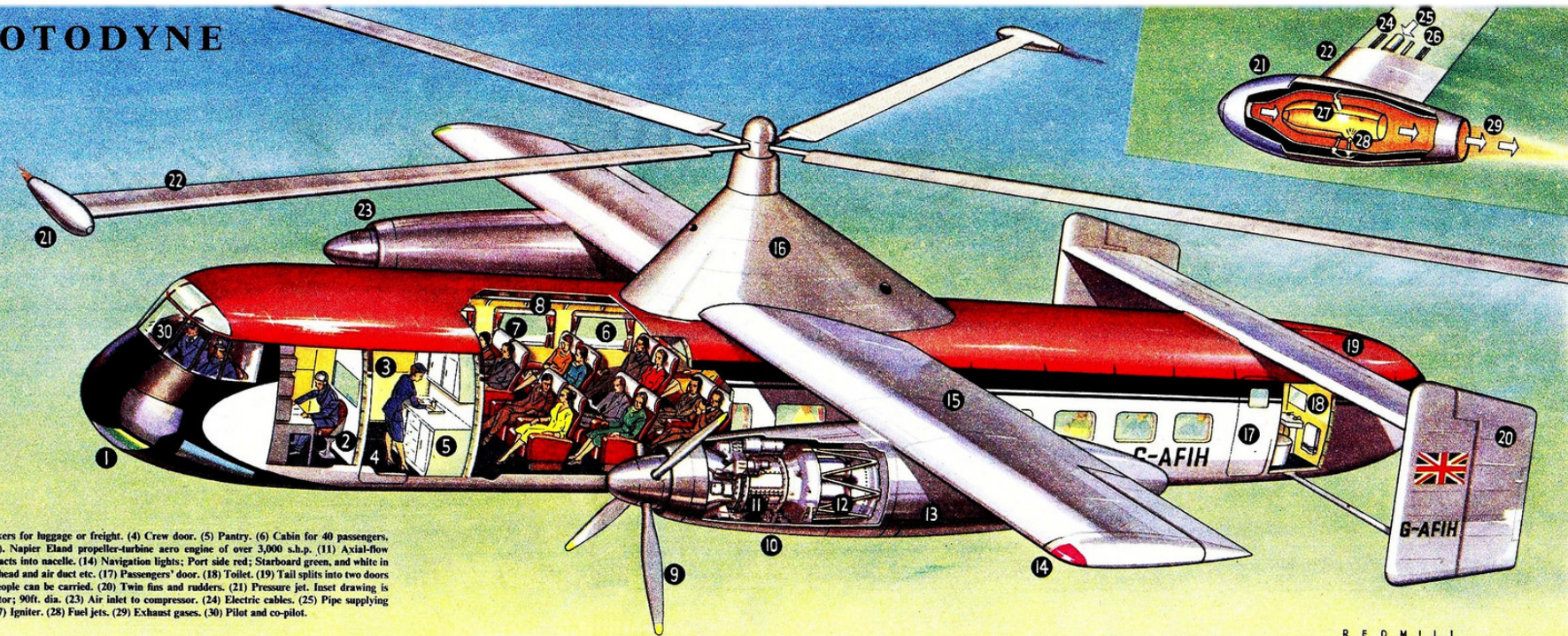
The wing will give additional lift when the machine is flying forward.

A speed of not less than 150 m.p.h. is expected to be achieved - which is high for a helicopter.

The cabin can be arranged in a variety of ways.

## KEY TO PARTS

(1) Windows to give pilot downward view. (2) Wireless Operator. (3) Lockers for luggage or freight. (4) Crew door. (5) Pantry. (6) Cabin for 40 passengers. (7) Adjustable seats. (8) Personal luggage rack. (9) 4-blade propellers. (10) Napier Eland propeller-turbine aero engine of over 3,000 s.h.p. (11) Axial-flow compressor. (12) Six tubular combustion chambers. (13) Undercarriage retracts into nacelle. (14) Navigation lights; Port side red; Starboard green, and white in tail. (15) Comparatively small wing, 47ft. span. (16) Pylon, carrying rotor-head and air duct etc. (17) Passengers' door. (18) Toilet. (19) Tail splits into two doors if aircraft is used as a freighter or car ferry. 3 medium size cars and 12 people can be carried. (20) Twin fins and rudders. (21) Pressure jet. Inset drawing is diagrammatic, only to show general principles of the system. (22) 4-blade rotor; 90ft. dia. (23) Air inlet to compressor. (24) Electric cables. (25) Pipe supplying compressed air from engine to pressure jet. (26) Fuel pipes and controls. (27) Igniter. (28) Fuel jets. (29) Exhaust gases. (30) Pilot and co-pilot.





# THE BOEING 707

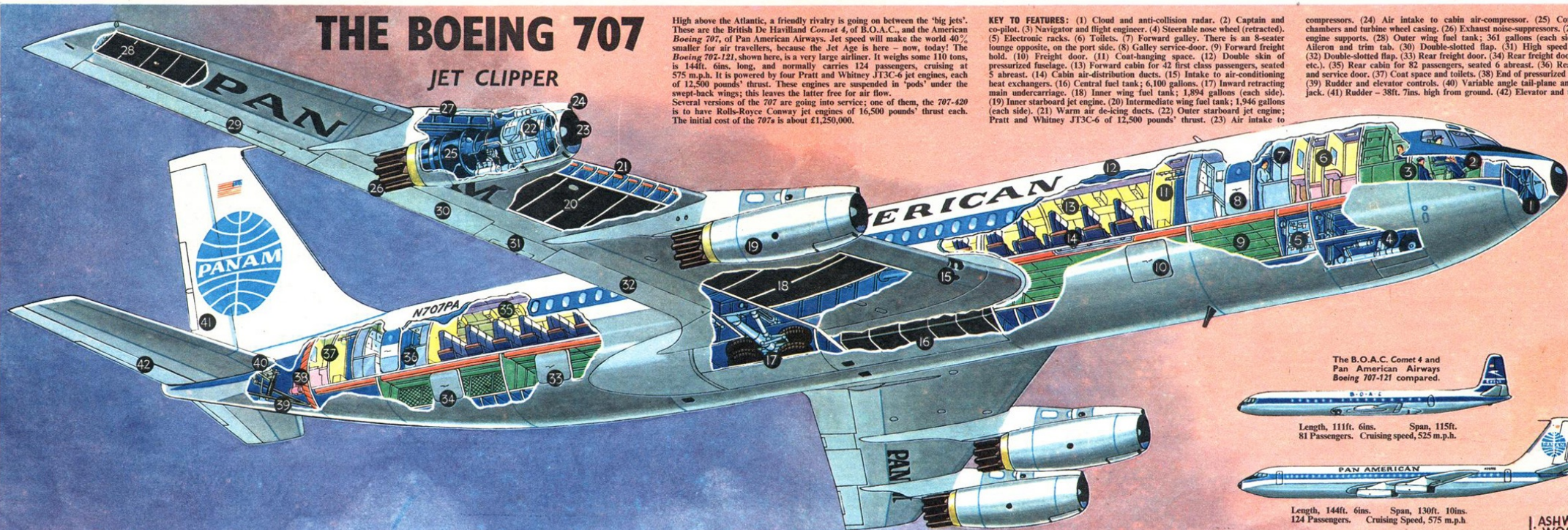
## JET CLIPPER

High above the Atlantic, a friendly rivalry is going on between the 'big jets'. These are the British De Havilland *Comet 4*, of B.O.A.C., and the American *Boeing 707*, of Pan American Airways. Jet speed will make the world 40% smaller for air travellers, because the Jet Age is here - now, today! The *Boeing 707-121*, shown here, is a very large airliner. It weighs some 110 tons, is 144ft. 6ins. long, and normally carries 124 passengers, cruising at 575 m.p.h. It is powered by four Pratt and Whitney JT3C-6 jet engines, each of 12,500 pounds' thrust. These engines are suspended in 'pods' under the swept-back wings; this leaves the latter free for air flow.

Several versions of the 707 are going into service; one of them, the 707-420 is to have Rolls-Royce Conway Jet engines of 16,500 pounds' thrust each. The initial cost of the 707s is about £1,250,000.

**KEY TO FEATURES:** (1) Cloud and anti-collision radar. (2) Captain and co-pilot. (3) Navigator and flight engineer. (4) Steerable nose wheel (retracted). (5) Electronic racks. (6) Toilets. (7) Forward galley. There is an 8-seater lounge opposite, on the port side. (8) Galley service-door. (9) Forward freight hold. (10) Freight door. (11) Coat-hanging space. (12) Double skin of pressurized fuselage. (13) Forward cabin for 42 first class passengers, seated 5 abreast. (14) Cabin air-distribution ducts. (15) Intake to air-conditioning heat exchangers. (16) Central fuel tank; 6,100 gallons. (17) Inward retracting main undercarriage. (18) Inner wing fuel tank; 1,894 gallons (each side). (19) Inner starboard jet engine. (20) Intermediate wing fuel tank; 1,946 gallons (each side). (21) Warm air de-icing ducts. (22) Outer starboard jet engine; Pratt and Whitney JT3C-6 of 12,500 pounds' thrust. (23) Air intake to

compressors. (24) Air intake to cabin air-compressor. (25) Combustion chambers and turbine wheel casing. (26) Exhaust noise-suppressors. (27) Main engine supports. (28) Outer wing fuel tank; 361 gallons (each side). (29) Aileron and trim tab. (30) Double-slotted flap. (31) High speed aileron. (32) Double-slotted flap. (33) Rear freight door (malls, etc.). (35) Rear cabin for 82 passengers, seated 6 abreast. (36) Rear galley and service door. (37) Coat space and toilets. (38) End of pressurized fuselage. (39) Rudder and elevator controls. (40) Variable angle tail-plane and screw-jack. (41) Rudder - 38ft. 7ins. high from ground. (42) Elevator and trim tab.



The B.O.A.C. Comet 4 and Pan American Airways Boeing 707-121 compared.

Length, 111ft. 6ins. Span, 115ft.  
81 Passengers. Cruising speed, 525 m.p.h.

Length, 144ft. 6ins. Span, 130ft. 10ins.  
124 Passengers. Cruising Speed, 575 m.p.h.

ASHWELL  
WOOD

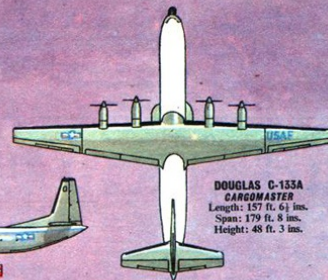


# AN AIR TRANSPORT GIANT

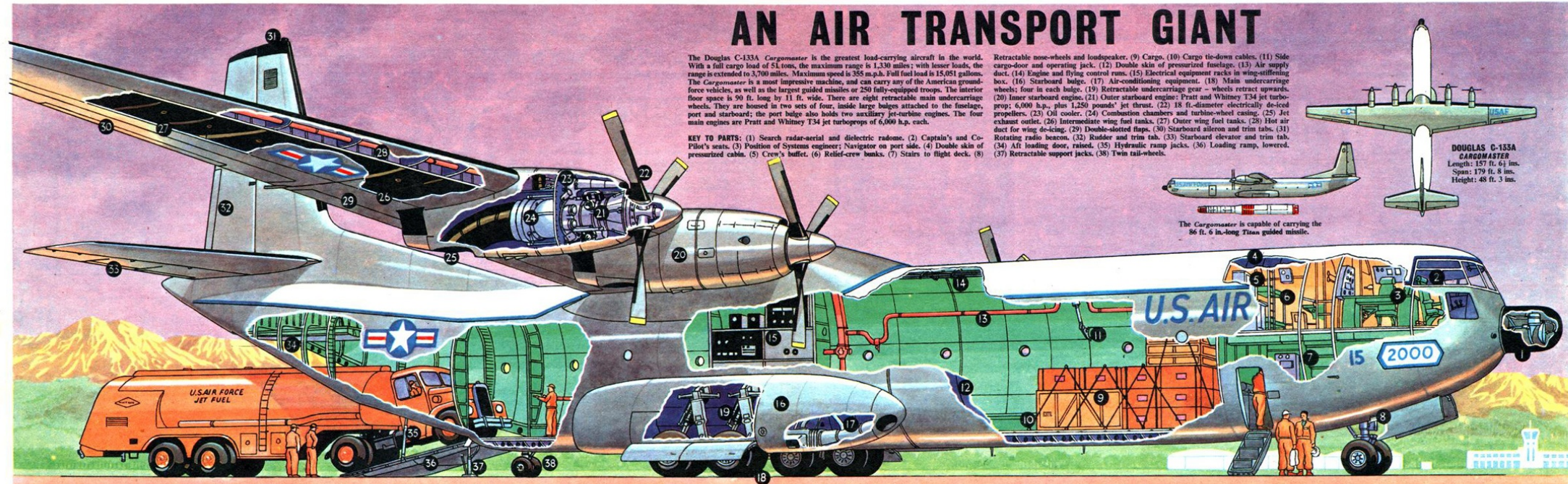
The Douglas C-133A *Cargomaster* is the greatest load-carrying aircraft in the world. With a full cargo load of 51 tons, the maximum range is 1,330 miles; with lesser loads, the range is extended to 3,700 miles. Maximum speed is 355 m.p.h. Full fuel load is 15,051 gallons. The *Cargomaster* is a most impressive machine, and can carry any of the American ground-force vehicles, as well as the largest guided missiles or 250 fully-equipped troops. The interior floor space is 90 ft. long by 11 ft. wide. There are eight retractable main undercarriage wheels. They are housed in two sets of four, inside large bulges attached to the fuselage, port and starboard; the port bulge also holds two auxiliary jet-turbine engines. The four main engines are Pratt and Whitney T34 jet turboprops of 6,000 h.p. each.

**KEY TO PARTS:** (1) Search radar-aerial and dielectric radome. (2) Captain's and Co-Pilot's seats. (3) Position of Systems engineer; Navigator on port side. (4) Double skin of pressurized cabin. (5) Crew's buffet. (6) Relief-crew bunks. (7) Stairs to flight deck. (8)

Retractable nose-wheels and loudspeaker. (9) Cargo. (10) Cargo tie-down cables. (11) Side cargo-door and operating jack. (12) Double skin of pressurized fuselage. (13) Air supply duct. (14) Engine and flying control runs. (15) Electrical equipment racks in wing-stiffening box. (16) Starboard bulge. (17) Air-conditioning equipment. (18) Main undercarriage wheels; four in each bulge. (19) Retractable undercarriage gear - wheels retract upwards. (20) Inner starboard engine. (21) Outer starboard engine: Pratt and Whitney T34 jet turboprop; 6,000 h.p., plus 1,250 pounds' jet thrust. (22) 18 ft.-diameter electrically de-iced propellers. (23) Oil cooler. (24) Combustion chambers and turbine-wheel casing. (25) Jet exhaust outlet. (26) Intermediate wing fuel tanks. (27) Outer wing fuel tanks. (28) Hot air duct for wing de-icing. (29) Double-slotted flaps. (30) Starboard aileron and trim tabs. (31) Rotating radio beacon. (32) Rudder and trim tab. (33) Starboard elevator and trim tab. (34) Aft loading door, raised. (35) Hydraulic ramp jacks. (36) Loading ramp, lowered. (37) Retractable support jacks. (38) Twin tail-wheels.



The *Cargomaster* is capable of carrying the 86 ft. 6 in.-long Titan guided missile.





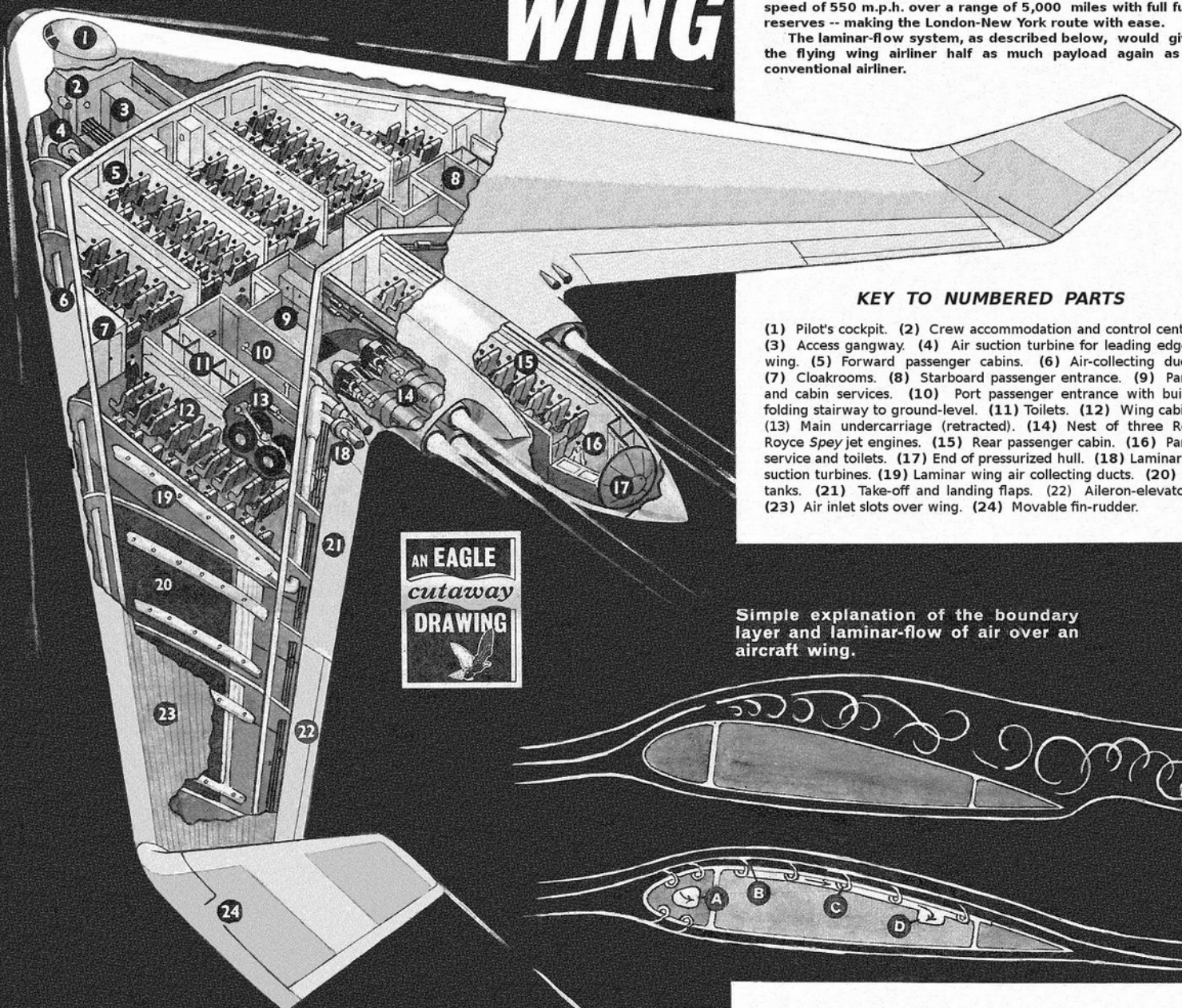
# FUTURE FLYING WING

This is a project for an all-wing airliner based on designs by Handley Page and code-numbered the H.P. 117. It would use the laminar-flow wing construction -- that is, reducing drag by controlling the air flow over the wing -- and would offer air travel to thousands of people at low cost.

The H.P. 117 would seat 300 passengers--accommodated in cabins within the wing thickness and central fuselage.

It will be powered by six Rolls-Royce Spey jet engines buried in the inboard part of the swept wing, giving a speed of 550 m.p.h. over a range of 5,000 miles with full fuel reserves -- making the London-New York route with ease.

The laminar-flow system, as described below, would give the flying wing airliner half as much payload again as a conventional airliner.

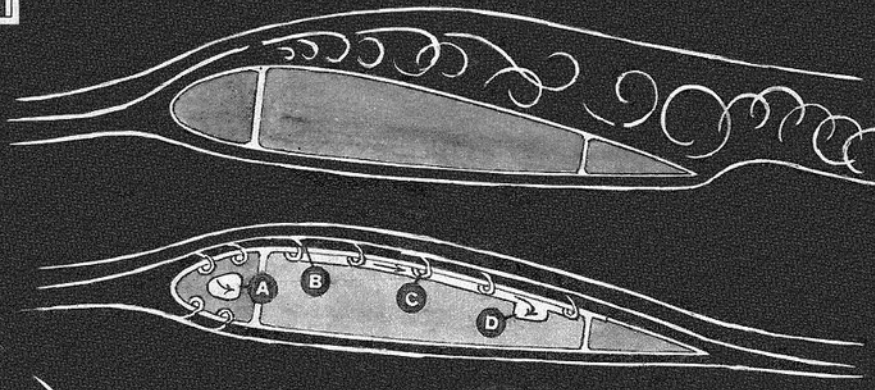


## KEY TO NUMBERED PARTS

- (1) Pilot's cockpit. (2) Crew accommodation and control centre. (3) Access gangway. (4) Air suction turbine for leading edge of wing. (5) Forward passenger cabins. (6) Air-collecting ducts. (7) Cloakrooms. (8) Starboard passenger entrance. (9) Pantry and cabin services. (10) Port passenger entrance with built-in folding stairway to ground-level. (11) Toilets. (12) Wing cabins. (13) Main undercarriage (retracted). (14) Nest of three Rolls-Royce Spey jet engines. (15) Rear passenger cabin. (16) Pantry service and toilets. (17) End of pressurized hull. (18) Laminar air-suction turbines. (19) Laminar wing air collecting ducts. (20) Fuel tanks. (21) Take-off and landing flaps. (22) Aileron-elevators. (23) Air inlet slots over wing. (24) Movable fin-rudder.



Simple explanation of the boundary layer and laminar-flow of air over an aircraft wing.



Top: The smooth flow of air over a wing is broken up by the tilt of the wing; this causes eddies in the boundary layer which break up and cause drag.

Bottom: In the laminar-flow wing, air is sucked in through tiny slots; this restores the smooth flow and reduces drag. (A) Slots. (B) Needle valves. (C) Front air-collecting duct. (D) Rear air-collecting duct.

H.P.117. ALL-WING AIRLINER  
(with passenger stairs and landing gear lowered)



L. ASHVELL  
WOOD



SPAN - 148 ft. 10½ ins.  
LENGTH - 149 ft. 6 ins.  
HEIGHT - 41 ft 9 ins.



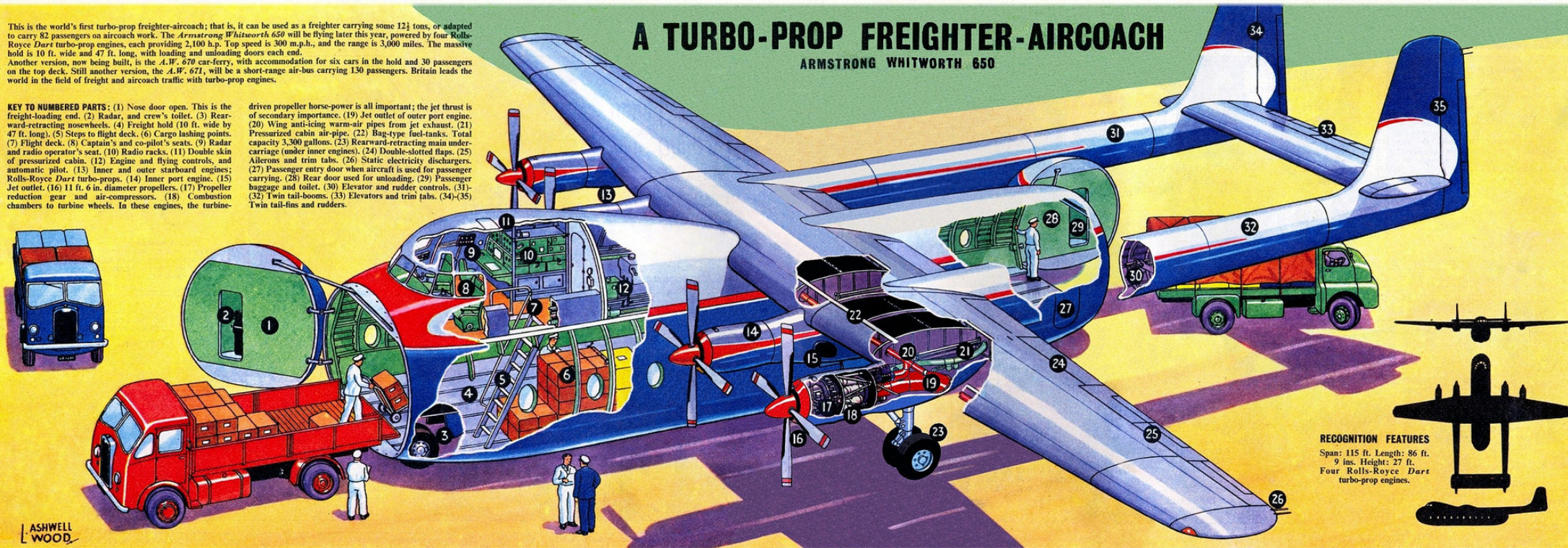
This is the world's first turbo-prop freighter-aircoach; that is, it can be used as a freighter carrying some 12½ tons, or adapted to carry 82 passengers on aircoach work. The *Armstrong Whitworth 650* will be flying later this year, powered by four Rolls-Royce *Dart* turbo-prop engines, each providing 2,100 h.p. Top speed is 300 m.p.h., and the range is 3,000 miles. The massive hold is 10 ft. wide and 47 ft. long, with loading and unloading doors each end. Another version, now being built, is the *A.W. 670* car-ferry, with accommodation for six cars in the hold and 30 passengers on the top deck. Still another version, the *A.W. 671*, will be a short-range air-bus carrying 130 passengers. Britain leads the world in the field of freight and aircoach traffic with turbo-prop engines.

**KEY TO NUMBERED PARTS:** (1) Nose door open. This is the freight-loading end. (2) Radar, and crew's toilet. (3) Rearward-retracting nosewheels. (4) Freight hold (10 ft. wide by 47 ft. long). (5) Steps to flight deck. (6) Cargo lashing points. (7) Flight deck. (8) Captain's and co-pilot's seats. (9) Radar and radio operator's seat. (10) Radio racks. (11) Double skin of pressurized cabin. (12) Engine and flying controls, and automatic pilot. (13) Inner and outer starboard engines; Rolls-Royce *Dart* turbo-props. (14) Inner port engine. (15) Jet outlet. (16) 11 ft. 6 in. diameter propellers. (17) Propeller reduction gear and air-compressors. (18) Combustion chambers to turbine wheels. In these engines, the turbine-

driven propeller horse-power is all important; the jet thrust is of secondary importance. (19) Jet outlet of outer port engine. (20) Wing anti-icing warm-air pipes from jet exhaust. (21) Pressurized cabin air-pipe. (22) Bag-type fuel-tanks. Total capacity 3,300 gallons. (23) Rearward-retracting main undercarriage (under inner engines). (24) Double-slotted flaps. (25) Ailerons and trim tabs. (26) Static electricity dischargers. (27) Passenger entry door when aircraft is used for passenger carrying. (28) Rear door used for unloading. (29) Passenger baggage and toilet. (30) Elevator and rudder controls. (31)-(32) Twin tail-booms. (33) Elevators and trim tabs. (34)-(35) Twin tail-fins and rudders.

# A TURBO-PROP FREIGHTER-AIRCOACH

## ARMSTRONG WHITWORTH 650



### RECOGNITION FEATURES

Span: 115 ft. Length: 86 ft.  
9 ins. Height: 27 ft.  
Four Rolls-Royce *Dart*  
turbo-prop engines.



# THE GOLDEN GATE BRIDGE

The Golden Gate Strait is so-called because ships passing out of San Francisco Bay into the Pacific in the evening, sail into the rays of the setting sun!

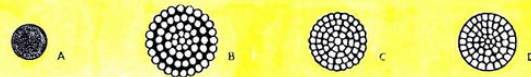
## KEY TO PARTS OF THE MAIN DRAWING

(1) North Pier, founded on rock in 20 ft. of water at foot of cliff, (2) South Pier, 1,125 ft. off shore and virtually in open sea. (3) Centre Span, 4,200 ft. long – the world's longest single suspended span; the deck hangs 250 ft. above water and is 90 ft. wide. It accommodates 6 lanes of traffic and 2 footways. (4) Approach Spans. (5) Stiffening truss, 25 ft. deep. (6) Both towers are 746 ft. high. (7) Cables; 36½ ins. in diameter, 90 ft. apart. (8) Cable Saddles. (9) Hangers. (10) Section of horizontal bracing; outer casing removed, showing girders. (11) Section of Tower Leg showing cellular design. At the base, each leg is built up of 97 cells, 3 ft. 6 ins. square, made of steel plates ½ inch thick. The towers are tapered by successively reducing the number of cells as the height increases, until at the top there are only 21 cells. (12) The South Pier was built inside a huge Fender, nicknamed 'The Bathtub' by the workmen. (13) The Fender is based on bedrock 100 ft. below water-level. (14) Base of Fender – concrete 65 ft. thick. (15) The Pier was built 'in the dry' inside, the water having been pumped out. When the work was completed, water was again allowed to enter inside the Fender, where it now helps to resist the force of wave action on the outer wall and so strengthens the foundations. (16) Fender Rim rises 15 ft. above water. (17) There are four 7½-knot tides, which sweep in and out of the Bay every 24 hours, and only four periods (of 20 minutes each) at the turn of each tide during which divers engaged on the underwater construction of the Fender could work! This is just one example of the many difficulties which presented themselves to the builders of this mighty bridge.

Before work could commence on this great bridge spanning the Golden Gate Strait, the United States War Department had to give its assent. They had to be satisfied that there was sufficient depth of water for the bridge to sink without causing any obstruction to shipping should it be wrecked at any time!

A glance at the map (extreme right), which shows the position of the bridge, makes this wise precaution all the more evident. San Francisco is one of the largest and most important American ports, whose wonderful bay provides excellent shelter to shipping.

## THE STRUCTURE OF THE MAIN CABLES

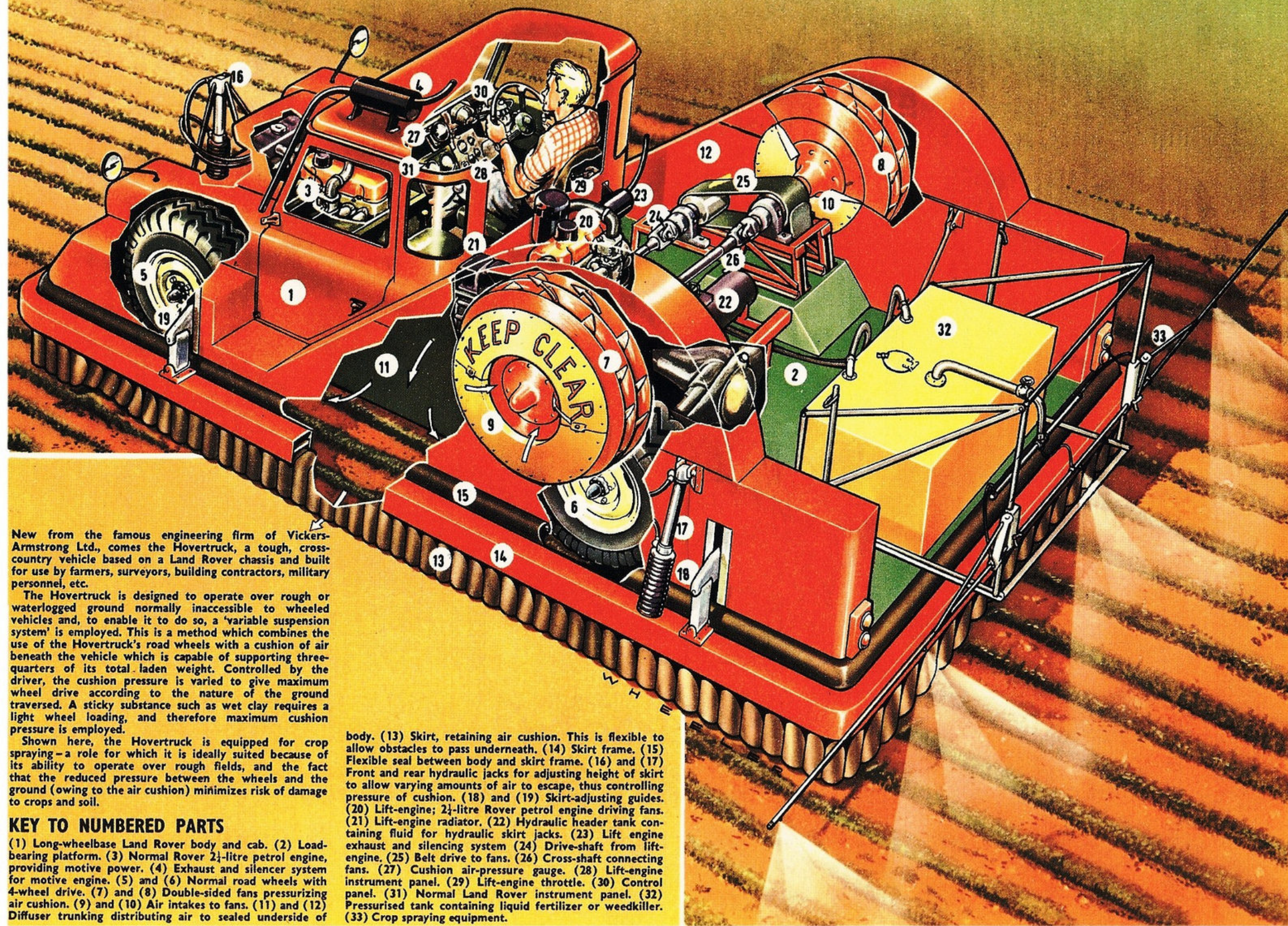


The steel wires, of which the cables are composed, are no thicker than piano wires and they are laid straight, without any spiral lay as in ordinary ropes. The cables are made up of 61 strands; in each strand there are 451 wires. (A) The 61 strands are laid into one cable . . . (B) and powerfully compacted. (C) shows them partly compacted. When fully compacted . . . (D) the strands become hexagonal in shape. Altogether there are 27,511 wires in each cable, which is 36½ inches in diameter.





# THE VICKERS HOVERTRUCK



New from the famous engineering firm of Vickers-Armstrong Ltd., comes the Hovertruck, a tough, cross-country vehicle based on a Land Rover chassis and built for use by farmers, surveyors, building contractors, military personnel, etc.

The Hovertruck is designed to operate over rough or waterlogged ground normally inaccessible to wheeled vehicles and, to enable it to do so, a 'variable suspension system' is employed. This is a method which combines the use of the Hovertruck's road wheels with a cushion of air beneath the vehicle which is capable of supporting three-quarters of its total laden weight. Controlled by the driver, the cushion pressure is varied to give maximum wheel drive according to the nature of the ground traversed. A sticky substance such as wet clay requires a light wheel loading, and therefore maximum cushion pressure is employed.

Shown here, the Hovertruck is equipped for crop spraying—a role for which it is ideally suited because of its ability to operate over rough fields, and the fact that the reduced pressure between the wheels and the ground (owing to the air cushion) minimizes risk of damage to crops and soil.

## KEY TO NUMBERED PARTS

(1) Long-wheelbase Land Rover body and cab. (2) Load-bearing platform. (3) Normal Rover 2½-litre petrol engine, providing motive power. (4) Exhaust and silencer system for motive engine. (5) and (6) Normal road wheels with 4-wheel drive. (7) and (8) Double-sided fans pressurizing air cushion. (9) and (10) Air intakes to fans. (11) and (12) Diffuser trunking distributing air to sealed underside of

body. (13) Skirt, retaining air cushion. This is flexible to allow obstacles to pass underneath. (14) Skirt frame. (15) Flexible seal between body and skirt frame. (16) and (17) Front and rear hydraulic jacks for adjusting height of skirt to allow varying amounts of air to escape, thus controlling pressure of cushion. (18) and (19) Skirt-adjusting guides. (20) Lift-engine; 2½-litre Rover petrol engine driving fans. (21) Lift-engine radiator. (22) Hydraulic header tank containing fluid for hydraulic skirt jacks. (23) Lift engine exhaust and silencing system (24) Drive-shaft from lift-engine. (25) Belt drive to fans. (26) Cross-shaft connecting fans. (27) Cushion air-pressure gauge. (28) Lift-engine instrument panel. (29) Lift-engine throttle. (30) Control panel. (31) Normal Land Rover instrument panel. (32) Pressurised tank containing liquid fertilizer or weedkiller. (33) Crop spraying equipment.



# THE CAR OF TOMORROW

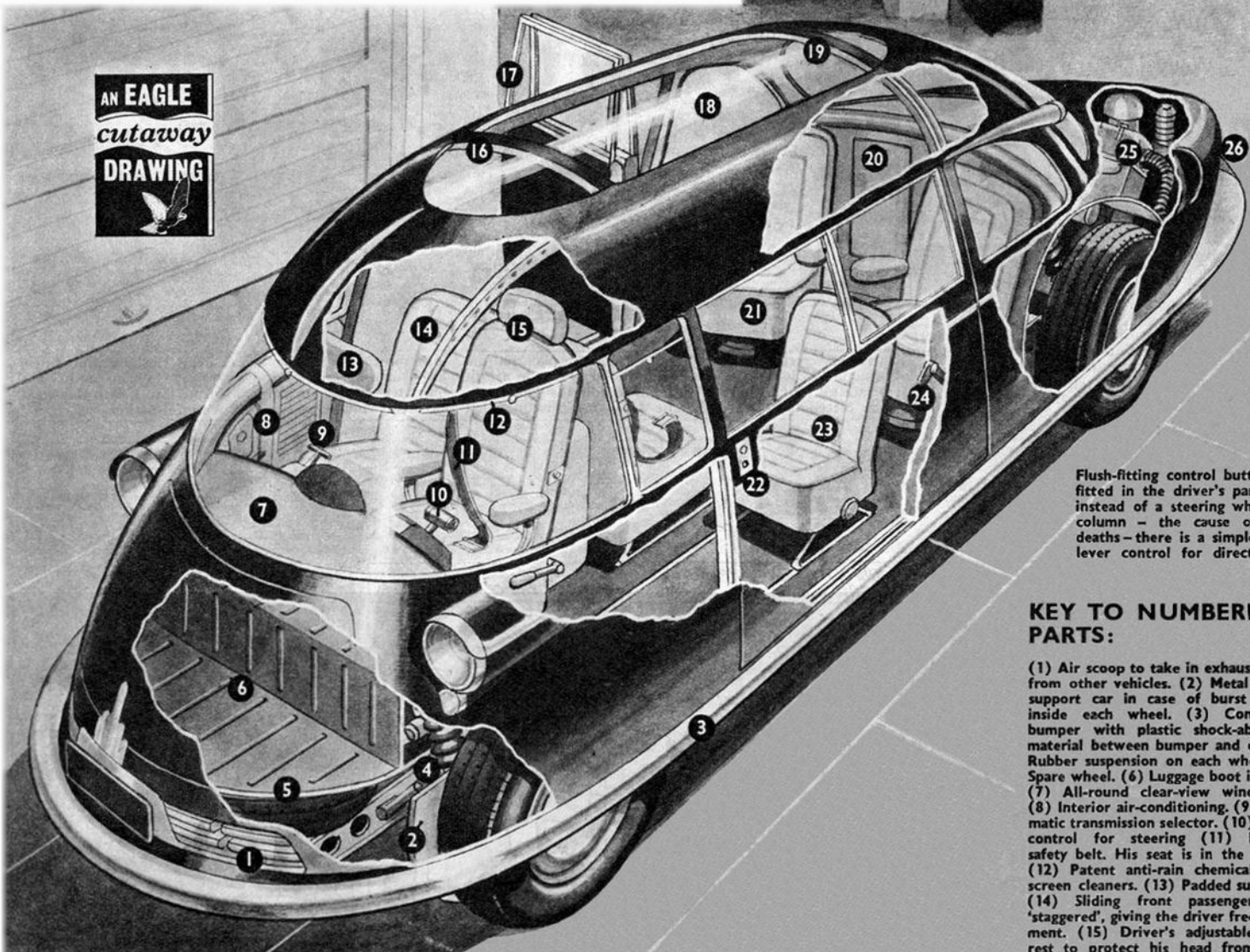
Most of the fatal accidents to motorists and passengers on the roads today could be prevented by a safety car as shown here. This drawing is based on the views and ideas of research workers in this country and the United States. The car of tomorrow, or 'survival' car, will be ultra-automatic in everything. You will walk up to the car, press a button and doors will open like the doors of a new telephone booth. The driver will not have to walk round to the offside

to get in, for his seat is in the middle of the front compartment. A comfortable 6-seater, the interior of the car of tomorrow will be free of protrusions, and all sharp edges, the cause of many injuries, will be padded. Steel roll-over bars in the roof will prevent crushing in the event of the car somersaulting.

It may be a pioneer car one day, without a lot of mechanical 'gadgets' but a wealth of crash-survival features, all practical ones.



AN EAGLE  
cutaway  
DRAWING

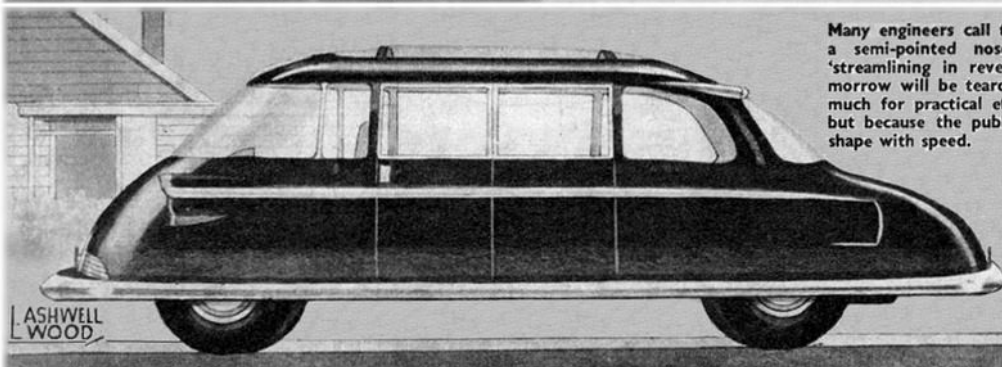


Flush-fitting control buttons are fitted in the driver's panel, and instead of a steering wheel and column - the cause of many deaths - there is a simple 'tiller' lever control for direction.

## KEY TO NUMBERED PARTS:

- (1) Air scoop to take in exhaust fumes from other vehicles.
- (2) Metal rim to support car in case of burst tyre - inside each wheel.
- (3) Continuous bumper with plastic shock-absorbing material between bumper and car.
- (4) Rubber suspension on each wheel.
- (5) Spare wheel.
- (6) Luggage boot in front.
- (7) All-round clear-view windscreen.
- (8) Interior air-conditioning.
- (9) Automatic transmission selector.
- (10) 'Tiller' control for steering.
- (11) Driver's safety belt. His seat is in the middle.
- (12) Patent anti-rain chemical windscreen cleaners.
- (13) Padded sun visor.
- (14) Sliding front passenger seats 'staggered', giving the driver free movement.
- (15) Driver's adjustable head-rest to protect his head from being flung backwards in the event of a severe bump from behind.
- (16) Steel roll-over bars to roof, protecting occupants in the event of car somersaulting in an accident.
- (17) Accordion-type folding doors - less danger to passing cyclists, etc.
- (18) Transparent plastic roof. Admits sun rays but filters out the glare.
- (19) Rear roll-over bars.
- (20) Locker for portable table, etc. - fuel tank behind.
- (21) Revolving arm-chair rear seats.
- (22) Push-button door openers, also controlled from driver's seat.
- (23) Lightweight movable side seats for easy access.
- (24) Bolt bars for keeping doors closed in the event of collision.
- (25) Air-cooled high-capacity engine with rock wool jacket for thermostatic air heating of car interior.
- (26) Strong engine protection at rear.

Many engineers call the present car, with a semi-pointed nose and blunt stern, 'streamlining in reverse'. The car of tomorrow will be teardrop in shape, not so much for practical effect of streamlining, but because the public will associate this shape with speed.

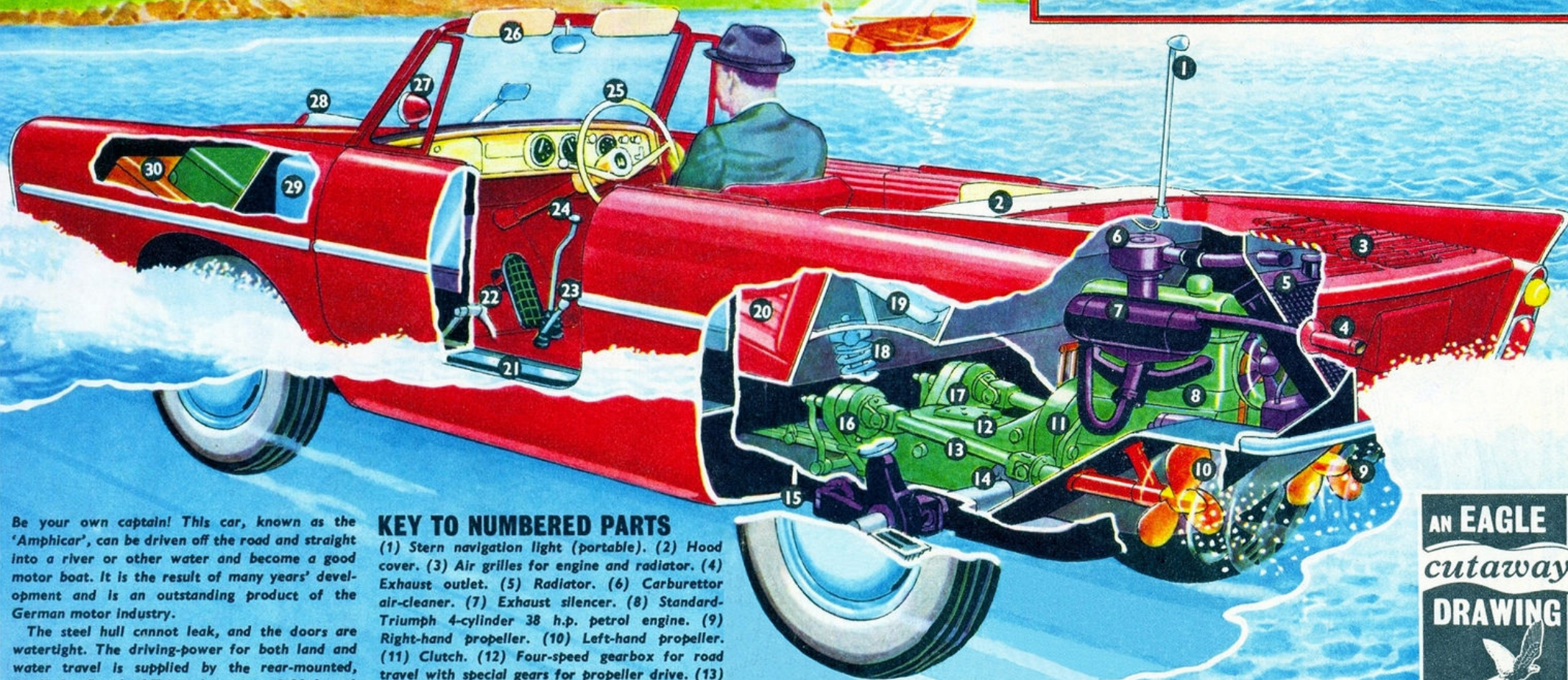
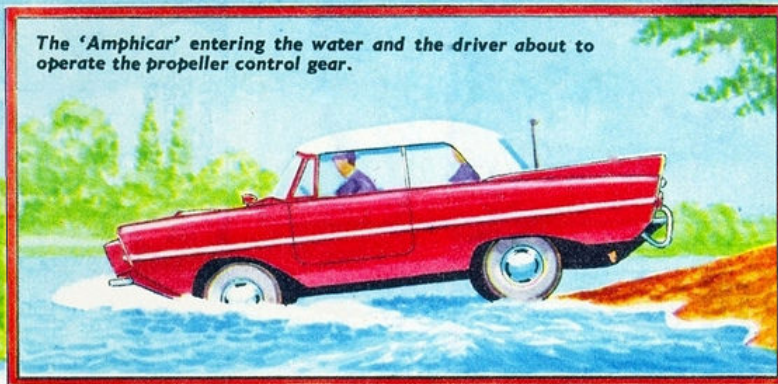


ASHWELL  
WOOD



# A CAR THAT SWIMS

The 'Amphicar' entering the water and the driver about to operate the propeller control gear.



Be your own captain! This car, known as the 'Amphicar', can be driven off the road and straight into a river or other water and become a good motor boat. It is the result of many years' development and is an outstanding product of the German motor industry.

The steel hull cannot leak, and the doors are watertight. The driving-power for both land and water travel is supplied by the rear-mounted, 4-cylinder Standard-Triumph engine of 38 h.p. A four-speed gearbox is used for driving the two 3-bladed plastic propellers. Steering on water, as on land, is by the front wheels.

The 'Amphicar' has a good road performance, with a maximum speed of 75 m.p.h. Petrol consumption is 35 miles per gallon. Maximum water speed is 7½ m.p.h. with a petrol consumption of three fifths of a gallon per hour. Navigation lights are fitted to permit night travel.

## KEY TO NUMBERED PARTS

(1) Stern navigation light (portable). (2) Hood cover. (3) Air grilles for engine and radiator. (4) Exhaust outlet. (5) Radiator. (6) Carburettor air-cleaner. (7) Exhaust silencer. (8) Standard-Triumph 4-cylinder 38 h.p. petrol engine. (9) Right-hand propeller. (10) Left-hand propeller. (11) Clutch. (12) Four-speed gearbox for road travel with special gears for propeller drive. (13) Propeller shaft. (14) Road drive-shaft to rear wheels. (15) Special watertight steel body. (16 and 17) Vee-drive from gearbox to propeller shafts. (18) Rear independent suspension on axle. (19) Plastic hood (stowed). (20) Rear seats. (21) Special watertight sealing on doors. (22) Special door-sealing lock. (23) Propeller gear control. (24) Road gear-change lever. (25) Steering, which acts through the front wheels for both road and water driving. (26) Anti-glare shields. (27) Warning horn. (28) Forward navigation lights for water driving. (29) Petrol tank - 10½ gallons' capacity. (30) Luggage boot (spare wheel underneath).

AN EAGLE  
cutaway  
DRAWING

ASHWELL  
WOOD



# FLYING FLIVVERS!

**H**OPPING about from place to place in autogyros and helicopters is no longer a dream of the future! The families flying overhead while we sit in our cars in traffic jams are still a minority, but one similar to the minority that once drove horseless-carriages!

Many of the 93 pilots in this country who are licensed to fly helicopters do so as part of their business - with week-end flips for the family. Others share, borrow or hire just for the sheer delight of flying. Among these are a number of youngsters, including three girls - so boys, look out!

Autogyro and helicopter prices are at present well over the Rolls-Royce range, but in a few years' time they will be cheap enough to be a practical proposition for many more people.

We show here a gyrocopter (or autogyro) and two popular types of helicopter.

The gyrocopter requires a small run for take-off, but helicopters can rise vertically. Both are able to travel a hundred miles at twice the speed of a car, and land in any accessible spot - even a garden lawn!

The lightweight Wallis WA-116 Gyrocopter should become increasingly popular for private coping. Gyrocopters (or autogyros) differ from helicopters in that their rotor blades are not powered in flight - revolving freely in the airstream to give lift, having first been spun-up on take-off by a special device from the engine. Top speed, 120 m.p.h. Range, 200 miles.



## KEY TO NUMBERED PARTS

- (1) Free-revolving rotor blades. (2) Fore and aft blade pitch control. (3) Side-to-side roll control. (4) Rotor brake handle, used after landing. (5) Gearbox drive. (6) Flexible drive from engine for spinning-up on take-off. (7) Control rods. (8) Carburettor air intake. (9) Spin-up disconnection for use when in flight. (10) McCulloch flat-four cylinder, 72 h.p. engine. (11) Air-cooling scoops for engine. (12) Rubber spin-up drive wheel. (13) Two-bladed pusher propeller - gives forward speed in the normal way. (14) Rudder balance. (15) Rudder of birch ply covered with fabric. (16) Rudder cable from foot pedals. (17) Main frame aluminium tube. (18) Petrol tank - 8 gallons. (19) Main undercarriage with wheel brakes - each side. (20) Rotor head control linkage from pilot's control column. (21) Spin-up drive control. (22) Engine throttle. (23) Control column for pitch and roll. (24) Instrument panel - altimeter, airspeed and rotor rev-counter. (25) Nose wheel steerable by foot bar. (26) Rudder pedals. (27) Pitot head for airspeed indicator.

Here are two types of helicopter, both American, for family and business flying.

The Brantly B2B two-seater (left) can be bought or hired from the British Executive Air Services. It has a two bubble cabin, a straight, tapered conical fuselage and skid-landing gear. The 180 h.p. Lycoming engine drives the 23 ft. 9 in.-diameter rotor and the tail rotor for steering. Cruising speed, 90 m.p.h. Range, 250 miles.

The Hughes 300 three-seater (right) can carry a load of 720 lb. for 200 miles at 80 m.p.h. The 180 h.p. Lycoming engine drives the 25 ft. 4 in.-diameter rotor and the tail rotor.



# THE RECORD BREAKING SWIFT

## FIGHTER 4

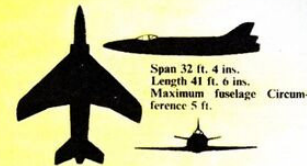
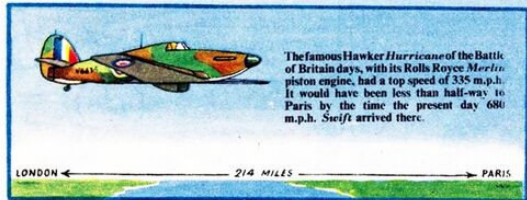
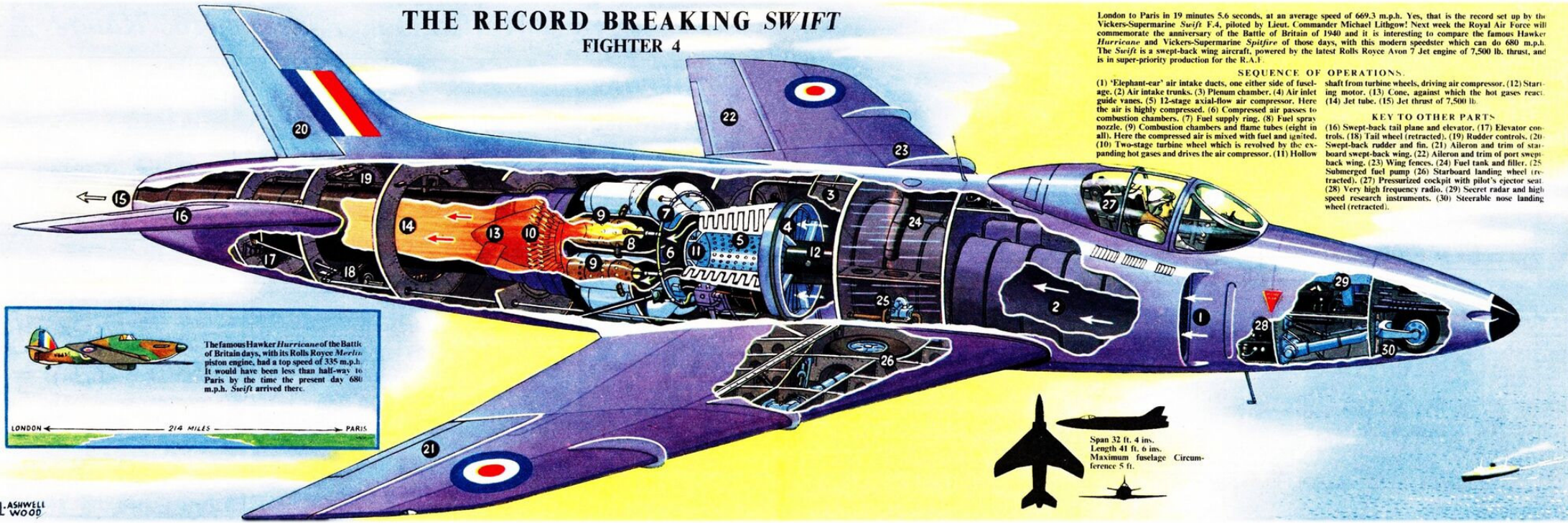
London to Paris in 19 minutes 5.6 seconds, at an average speed of 669.3 m.p.h. Yes, that is the record set up by the Vickers-Supermarine *Swift* F.4, piloted by Lieut. Commander Michael Lithgow! Next week the Royal Air Force will commemorate the anniversary of the Battle of Britain of 1940 and it is interesting to compare the famous Hawker *Hurricane* and Vickers-Supermarine *Spitfire* of those days, with this modern speedster which can do 680 m.p.h. The *Swift* is a swept-back wing aircraft, powered by the latest Rolls Royce Avon 7 Jet engine of 7,500 lb. thrust, and is in super-priority production for the R.A.F.

### SEQUENCE OF OPERATIONS.

- (1) 'Elephant-ear' air intake ducts, one either side of fuselage. (2) Air intake trunks. (3) Plenum chamber. (4) Air inlet guide vanes. (5) 12-stage axial-flow air compressor. Here the air is highly compressed. (6) Compressed air passes to combustion chambers. (7) Fuel supply ring. (8) Fuel spray nozzle. (9) Combustion chambers and flame tubes (eight in all). Here the compressed air is mixed with fuel and ignited. (10) Two-stage turbine wheel which is revolved by the expanding hot gases and drives the air compressor. (11) Hollow shaft from turbine wheels, driving air compressor. (12) Starting motor. (13) Cone, against which the hot gases react. (14) Jet tube. (15) Jet thrust of 7,500 lb.

### KEY TO OTHER PARTS

- (16) Swept-back tail plane and elevator. (17) Elevator controls. (18) Tail wheel (retracted). (19) Rudder controls. (20) Swept-back rudder and fin. (21) Aileron and trim of starboard swept-back wing. (22) Aileron and trim of port swept-back wing. (23) Wing fences. (24) Fuel tank and filler. (25) Submerged fuel pump. (26) Starboard landing wheel (retracted). (27) Pressurized cockpit with pilot's ejector seat. (28) Very high frequency radio. (29) Secret radar and high speed research instruments. (30) Steerable nose landing wheel (retracted).



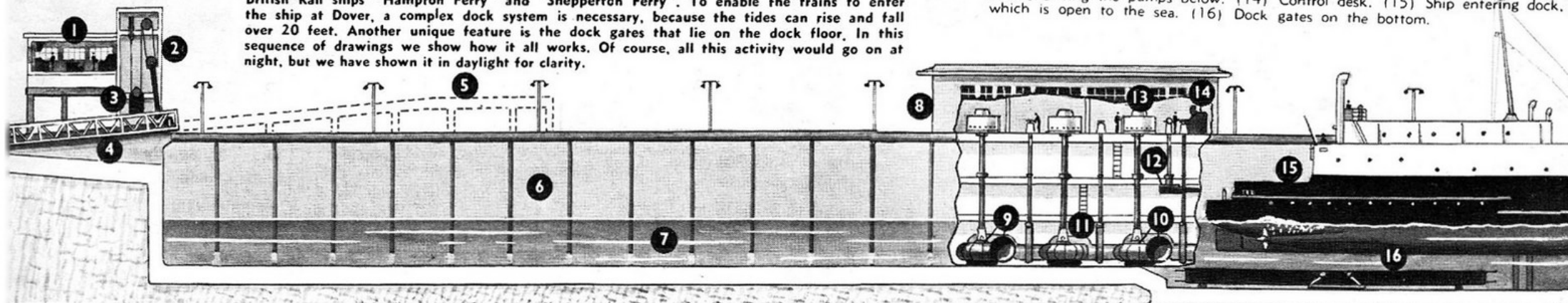


# BY BED TO PARIS!

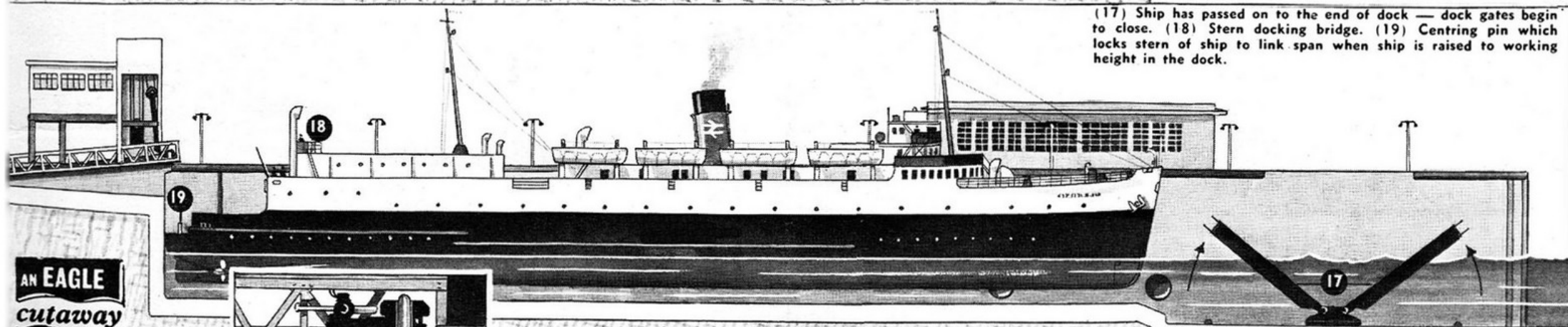
The crossing of the English Channel was a problem in Roman days. Today, passengers can enter the night ferry train at Victoria Station, London, speed to Dover in a sleeping car, board the train ferry ship without waking up and cross to Dunkerque. From there the train continues the journey to Paris, the passengers arriving fresh in the morning.

All this comes about by the Dover-Dunkerque train ferry service run by the two 2,840-ton British Rail ships 'Hampton Ferry' and 'Shepperton Ferry'. To enable the trains to enter the ship at Dover, a complex dock system is necessary, because the tides can rise and fall over 20 feet. Another unique feature is the dock gates that lie on the dock floor. In this sequence of drawings we show how it all works. Of course, all this activity would go on at night, but we have shown it in daylight for clarity.

(1) Railway signal cabin of the Dover Ferry control building. (2) Diagram of link span hoisting the machinery. (3) Counterbalance weight — one on each side of link span. (4) Link span with railway tracks in raised position clear of ship. (5) Position of car loading ramp — this is on the near side of dock. (6) Dock wall lined with timber fenders. (7) Low tide level over dock floor. (8) Pump house. (9-10) Powerful centrifugal pumps and culverts for inlet or outlet of water from the sea. These raise or lower the water level in the dock when the gates are closed. (11) Stand-by pump. (12) Gate controls. (13) Electric motors driving the pumps below. (14) Control desk. (15) Ship entering dock. (16) Dock gates on the bottom.

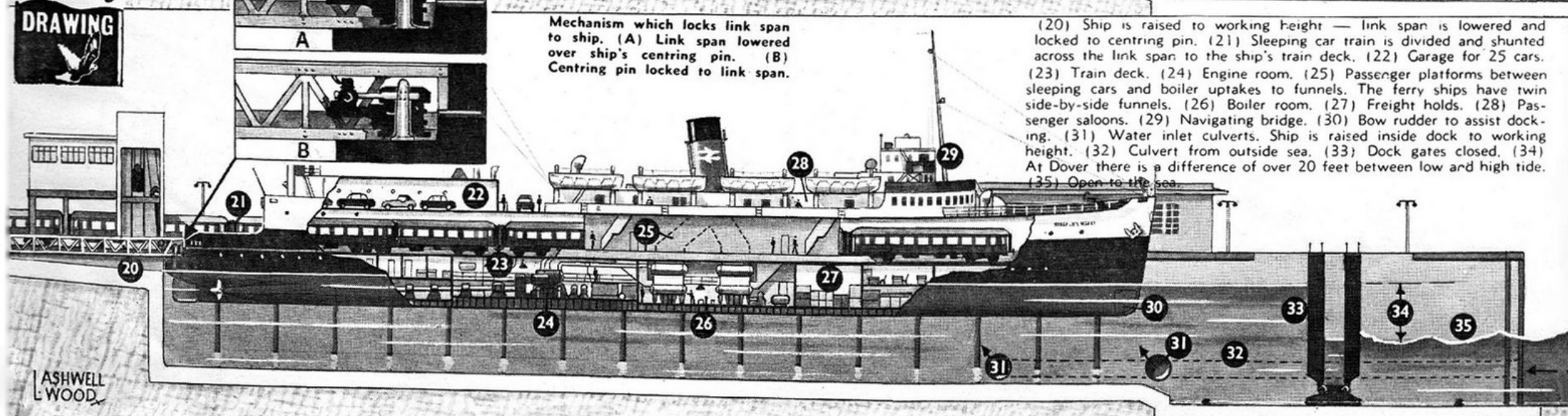


(17) Ship has passed on to the end of dock — dock gates begin to close. (18) Stern docking bridge. (19) Centring pin which locks stern of ship to link span when ship is raised to working height in the dock.



AN EAGLE  
cutaway  
DRAWING

Mechanism which locks link span to ship. (A) Link span lowered over ship's centring pin. (B) Centring pin locked to link span.



(20) Ship is raised to working height — link span is lowered and locked to centring pin. (21) Sleeping car train is divided and shunted across the link span to the ship's train deck. (22) Garage for 25 cars. (23) Train deck. (24) Engine room. (25) Passenger platforms between sleeping cars and boiler uptakes to funnels. The ferry ships have twin side-by-side funnels. (26) Boiler room. (27) Freight holds. (28) Passenger saloons. (29) Navigating bridge. (30) Bow rudder to assist docking. (31) Water inlet culverts. Ship is raised inside dock to working height. (32) Culvert from outside sea. (33) Dock gates closed. (34) At Dover there is a difference of over 20 feet between low and high tide. (35) Open to the sea.

ASHWELL  
WOOD



# "CUTTY SARK"

## THE MOST FAMOUS OF ALL CLIPPERS

The *Cutty Sark* was designed and built in 1869 to rival the *Thermopylae*, another clipper ship, with whom she had many an exciting race bringing the first of the season's tea from China, or the wool from Australia.

She was one of the best loved ships flying the Red Ensign, so a permanent home is going to be found for her in a dry dock, by the *Cutty Sark* Preservation Society.

The *Cutty Sark* is a composite, full rigged ship - that is, she has iron frames planked over with wood.

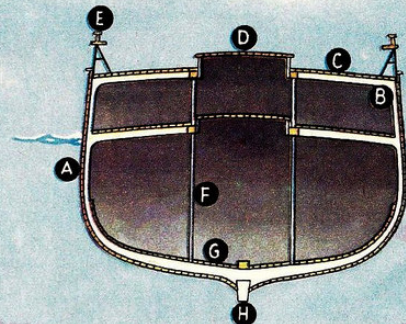
She has three masts, fore, main and mizzen and is essentially an aristocrat of the sailing ship family.

Of some 1,970 tons displacement (i.e. loaded), she has a length of 212½ ft. with a beam of 36 ft. and could carry a cargo of 1,000 tons. The cargo shown here was a typical one from Australia during her famous by-gone days.

You can wear a *Cutty Sark* Badge - see page 13.

### KEY TO PARTS

- |                                    |                                       |                             |                                                               |                                                          |                               |
|------------------------------------|---------------------------------------|-----------------------------|---------------------------------------------------------------|----------------------------------------------------------|-------------------------------|
| (1) Bowsprit.                      | (2) Figure-head.                      | (14) Main hatch.            | (15) Winch.                                                   | (16) Main mast.                                          | (17) Main-top mast.           |
| (3) Star-board anchor and capstan. | (4) Lower forecastle with crew space. | (18) Main-top-gallant mast. | (19) Hand pumps.                                              | (20) Half-deck house with accommodation for apprentices. | (21) After hatch.             |
| (5) Forecastle.                    | (6) Fore hatch.                       | (22) Mixed cargo.           | (23) Mizzen mast.                                             | (24) Mizzen-top mast.                                    | (25) Mizzen-top-gallant mast. |
| (7) Fore mast.                     | (8) Fore-top mast.                    | (26) Steering wheel.        | (27) Captain's and First Officer's accommodation with saloon. |                                                          |                               |



Cross section of hull of *Cutty Sark*, showing method of construction.

- (A) Wooden outer planking. (B) Iron frames and deck beams. (C) Wooden deck planking. (D) Hatch. (E) Wooden rails on metal bulwarks. (F) Iron stanchions. (G) Wooden hold planking. (H) Iron keel.



# THE TOWER BRIDGE

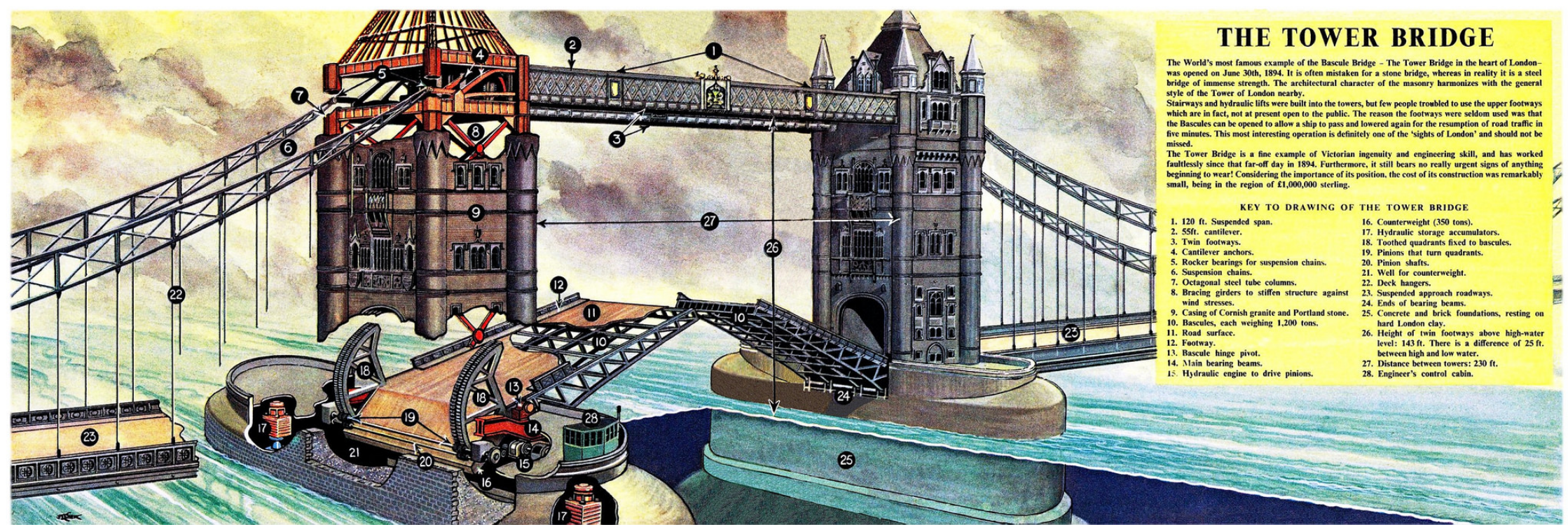
The World's most famous example of the Bascule Bridge - The Tower Bridge in the heart of London - was opened on June 30th, 1894. It is often mistaken for a stone bridge, whereas in reality it is a steel bridge of immense strength. The architectural character of the masonry harmonizes with the general style of the Tower of London nearby.

Stairways and hydraulic lifts were built into the towers, but few people troubled to use the upper footways which are in fact, not at present open to the public. The reason the footways were seldom used was that the Bascules can be opened to allow a ship to pass and lowered again for the resumption of road traffic in five minutes. This most interesting operation is definitely one of the 'sights of London' and should not be missed.

The Tower Bridge is a fine example of Victorian ingenuity and engineering skill, and has worked faultlessly since that far-off day in 1894. Furthermore, it still bears no really urgent signs of anything beginning to wear! Considering the importance of its position, the cost of its construction was remarkably small, being in the region of £1,000,000 sterling.

## KEY TO DRAWING OF THE TOWER BRIDGE

- |                                                                |                                                                                                                         |
|----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| 1. 120 ft. Suspended span.                                     | 16. Counterweight (350 tons).                                                                                           |
| 2. 55ft. cantilever.                                           | 17. Hydraulic storage accumulators.                                                                                     |
| 3. Twin footways.                                              | 18. Toothed quadrants fixed to bascules.                                                                                |
| 4. Cantilever anchors.                                         | 19. Pinions that turn quadrants.                                                                                        |
| 5. Rocker bearings for suspension chains.                      | 20. Pinion shafts.                                                                                                      |
| 6. Suspension chains.                                          | 21. Well for counterweight.                                                                                             |
| 7. Octagonal steel tube columns.                               | 22. Deck hangers.                                                                                                       |
| 8. Bracing girders to stiffen structure against wind stresses. | 23. Suspended approach roadways.                                                                                        |
| 9. Casing of Cornish granite and Portland stone.               | 24. Ends of bearing beams.                                                                                              |
| 10. Bascules, each weighing 1,200 tons.                        | 25. Concrete and brick foundations, resting on hard London clay.                                                        |
| 11. Road surface.                                              | 26. Height of twin footways above high-water level: 143 ft. There is a difference of 25 ft. between high and low water. |
| 12. Footway.                                                   | 27. Distance between towers: 230 ft.                                                                                    |
| 13. Bascule hinge pivot.                                       | 28. Engineer's control cabin.                                                                                           |
| 14. Main bearing beams.                                        |                                                                                                                         |
| 15. Hydraulic engine to drive pinions.                         |                                                                                                                         |

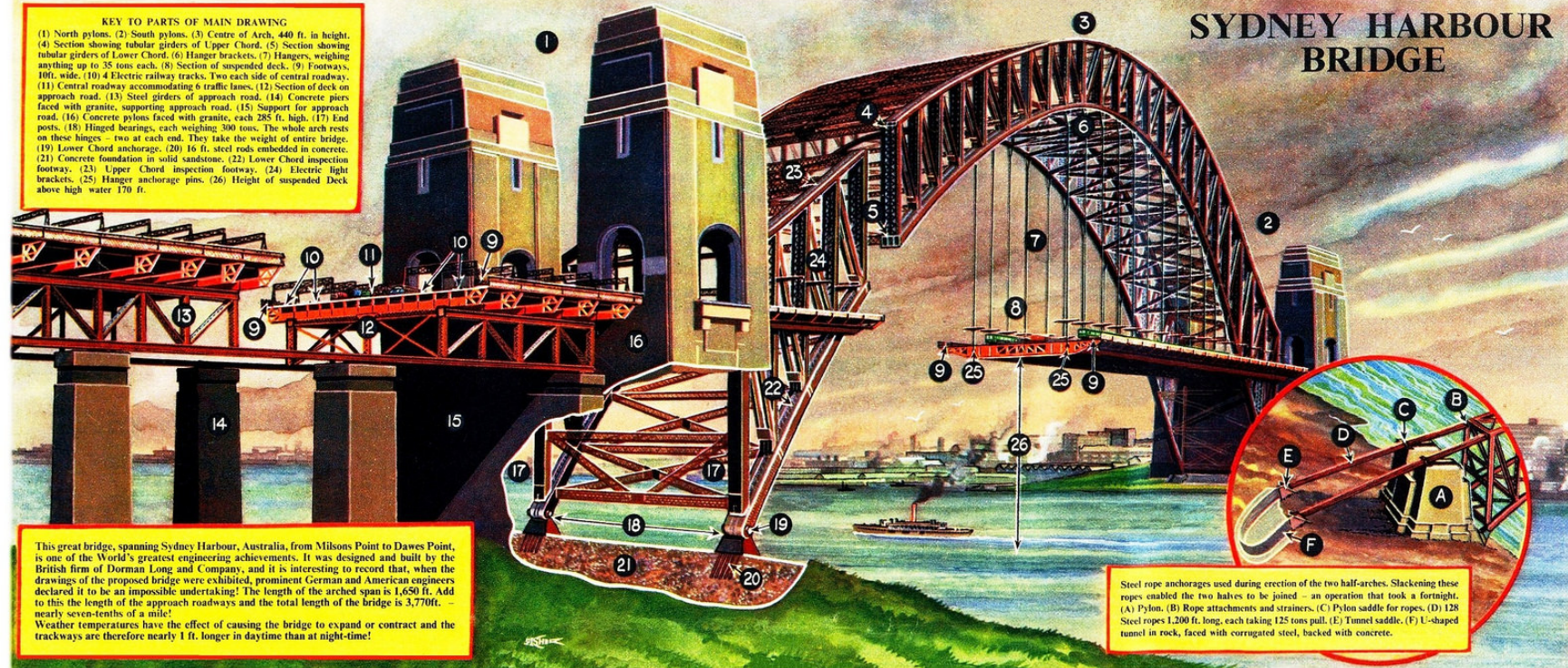




## KEY TO PARTS OF MAIN DRAWING

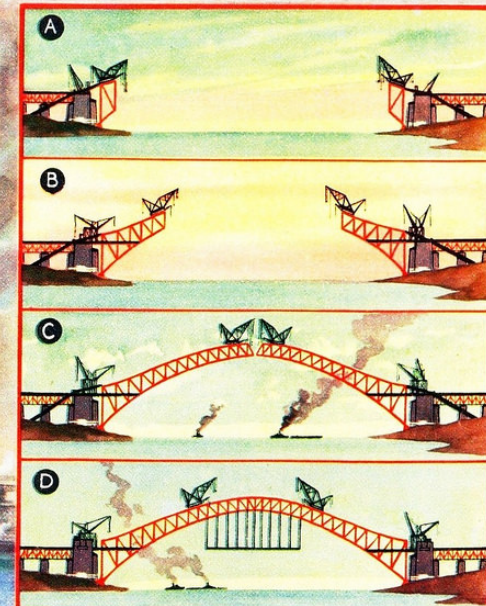
(1) North pylons. (2) South pylons. (3) Centre of Arch, 440 ft. in height. (4) Section showing tubular girders of Upper Chord. (5) Section showing tubular girders of Lower Chord. (6) Hanger brackets. (7) Hangers, weighing anything up to 35 tons each. (8) Section of suspended deck. (9) Footways, 10ft. wide. (10) 4 Electric railway tracks. Two each side of central roadway. (11) Central roadway accommodating 6 traffic lanes. (12) Section of deck on approach road. (13) Steel girders of approach road. (14) Concrete piers faced with granite, supporting approach road. (15) Support for approach road. (16) Concrete pylons faced with granite, each 285 ft. high. (17) End posts. (18) Hinged bearings, each weighing 300 tons. The whole arch rests on these hinges - two at each end. They take the weight of entire bridge. (19) Lower Chord anchorage. (20) 16 ft. steel rods embedded in concrete. (21) Concrete foundation in solid sandstone. (22) Lower Chord inspection footway. (23) Upper Chord inspection footway. (24) Electric light brackets. (25) Hanger anchorage pins. (26) Height of suspended Deck above high water 170 ft.

# SYDNEY HARBOUR BRIDGE



This great bridge, spanning Sydney Harbour, Australia, from Milsons Point to Dawes Point, is one of the World's greatest engineering achievements. It was designed and built by the British firm of Dorman Long and Company, and it is interesting to record that, when the drawings of the proposed bridge were exhibited, prominent German and American engineers declared it to be an impossible undertaking! The length of the arch span is 1,650 ft. Add to this the length of the approach roadways and the total length of the bridge is 3,770ft. - nearly seven-tenths of a mile! Weather temperatures have the effect of causing the bridge to expand or contract and the trackways are therefore nearly 1 ft. longer in daytime than at night-time!

Steel rope anchorages used during erection of the two half-arches. Slackening these ropes enabled the two halves to be joined - an operation that took a fortnight. (A) Pylon. (B) Rope attachments and strainers. (C) Pylon saddle for ropes. (D) 128 Steel ropes 1,200 ft. long, each taking 125 tons pull. (E) Tunnel saddle. (F) U-shaped tunnel in rock, faced with corrugated steel, backed with concrete.



## STAGES IN THE BUILDING OF THE BRIDGE.

During the whole of the construction period, the passage of shipping was uninterrupted. (A) Rope anchorages in position. First panels of arch erected. Creepers cranes travel along top chords. (B) Five panels erected. Creepers advance. (C) Gap almost closed. Anchorage ropes are eased out one by one on both sides. (D) Arch finished. Centre section of deck erected. Anchorage ropes dismantled. Cranes retreat down upper chords.



# BOEING B-47 "STRATOJET"

## AMERICA'S SIX-JET ATOM-BOMBER



ALTHOUGH the B-47 has now been overshadowed by its powerful stable-companion, the Boeing B-52, it was for many years the leading medium bomber in the world.

The basic design was planned in 1945. Its chief characteristics as regards the design are, of course,

the wings which sweep back at an angle of 35 degrees, and the six turbo jets arranged in "pods."

The prototype Stratojet first flew in 1947, and the aircraft went into service in 1951. Between then and 1957, when production ceased, 2,040 Stratojets were built.

The version of which most were made is the B-47E, powered by six General Electric turbojets,

each delivering 6,000 lb. thrust dry, and 7,200 lb. with water injection.

There is no outward difference between the B-47E and earlier versions, with the exception of the tail unit. On the B-47E, this is a radar-controlled twin 20-mm. gun position. It automatically "picks up" any aircraft that approach, tracks them, sets the guns and fires them. This version flew for the first time in 1953.

There is also a version for crew training, known as the ETB-47E, and the RB-47E, built for photographic reconnaissance. For this purpose the nose was extended to hold an additional camera.

The B-47 carries a crew of three—pilot, co-pilot, and bombardier/navigator.

It has a maximum load of 20,000 lb. and a normal top speed of 640 m.p.h.

The aircraft's normal range is 4,000 miles—though on one occasion, by the use of in-flight refuelling, a B-47 made a non-stop flight of 21,000 miles, lasting nearly two days.

Nowadays B-47s are used for special reconnaissance work, tanking, weather missions, crew training, and as a target drone.

**A SUPER CUTAWAY PICTURE OF A MIGHTY SUBMARINE-SMASHING PLANE WILL APPEAR IN NEXT MONDAY'S LION**



# The Floating Weight-Lifter

The 'London Samson' is a completely new and revolutionary type of self-propelled floating crane, to be installed by the Port of London Authority for service in London's Docks and on the tideway of the River Thames to Tilbury.

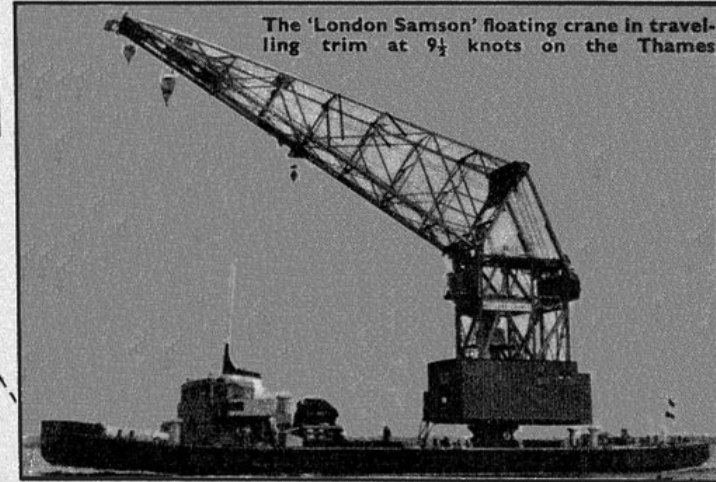
Apart from her weight-lifting capabilities, she can manoeuvre in her own length by means of two Voith Schneider propeller units - one aft and one forward. She can even 'park' sideways.

Briefly, the propulsion is obtained by blades set in a circle which revolve horizontally - not vertically as in normal propellers. The blades can be moved so as to give a thrust in any desired direction, thus dispensing with the normal steering gear.

This self-propelled giant is powered by six Rolls-Royce Diesel engines, totalling 1,800 h.p.

The huge crane can lift 60 tons at a maximum radius of 90 ft. or, with special pulleys, 120 tons at a maximum radius of 40 ft. Height of lift can be 100 ft. above water level. Hull length, 180 ft.; beam, 58 ft. 6 ins. Our drawing was prepared with the kind assistance of the Port of London Authority.

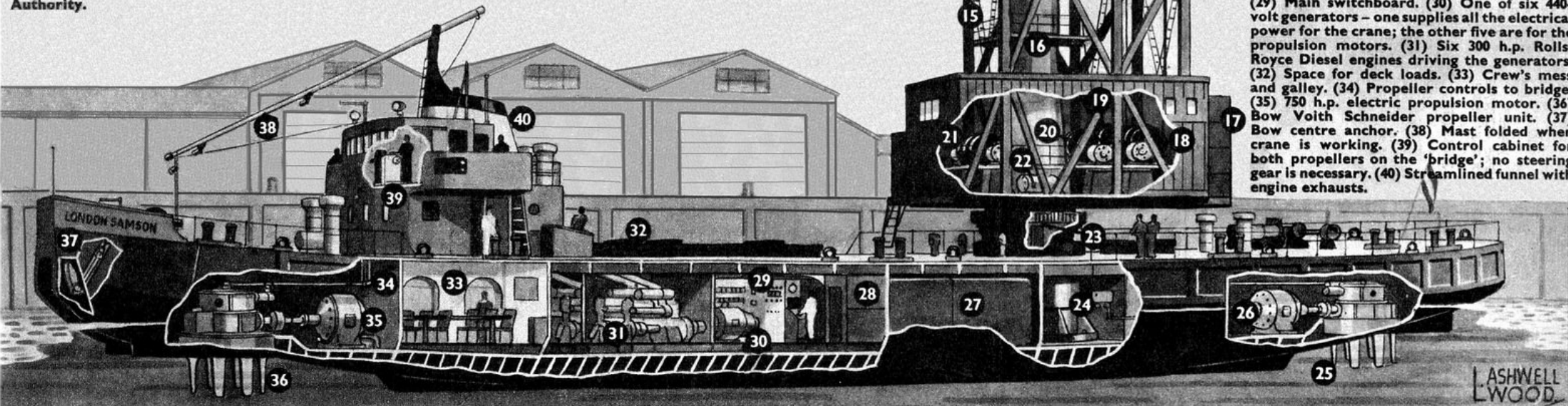
AN EAGLE  
cutaway  
DRAWING



The 'London Samson' floating crane in travelling trim at 9½ knots on the Thames

## KEY TO NUMBERED PARTS

- (1) Jib head. (2) 20-ton lift auxiliary hoist. (3) 60-ton lift main hoist. (4) 5-ton lift jigger hoist. (5) Travelling trolley for the jigger hoist. (6) Crane jib. (7) Position of jib when fully raised. (8) Maximum radius of main hoist for 120-ton lift. (9) Crane driver's cab with 'joy-stick' controls for all movements. (10) Jigger hoist pulleys and wire ropes. (11) Auxiliary hoist pulleys and wire ropes. (12) Main hoist pulleys and wire ropes. (13) Derricking or jib-raising pulleys and wire ropes. (14) Jib counterbalance weight - this slides up or down with the jib movement. (15) Crane revolving structure. (16) Conical steel pivot about which the whole crane revolves. (17) Main counterbalance weights. (18) 30 h.p. jib derricking electric motor. (19) 60 h.p. main hoist motor. (20) 40 h.p. auxiliary hoist motor. (21) 25 h.p. jigger hoist and trolley motors. (22) 35 h.p. crane revolving motor. (23) Turntable gearing and 440 volts supply cables to all motors. (24) Base of main support pivot. (25) Stern Voith Schneider propeller unit. (26) 750 h.p. electric propulsion motor. (27) Engine fuel-oil tanks. (28) Stores. (29) Main switchboard. (30) One of six 440-volt generators - one supplies all the electrical power for the crane; the other five are for the propulsion motors. (31) Six 300 h.p. Rolls-Royce Diesel engines driving the generators. (32) Space for deck loads. (33) Crew's mess and galley. (34) Propeller controls to bridge. (35) 750 h.p. electric propulsion motor. (36) Bow Voith Schneider propeller unit. (37) Bow centre anchor. (38) Mast folded when crane is working. (39) Control cabinet for both propellers on the 'bridge'; no steering gear is necessary. (40) Streamlined funnel with engine exhausts.



L. ASHWELL  
L. WOOD

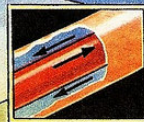


# BRITAIN'S LATEST ATOMIC RESEARCH STATION

The Dounreay Atomic establishment is being built a few miles from Thurso, on the Caithness coast, northern Scotland. The atomic reactor is built inside a huge sphere, 135 ft. in diameter, which dominates the site and captures the imagination. Unlike the other atomic centres in Britain which produce power for giant electricity power stations, Dounreay is primarily for research and development, and to study the 'fuel' elements for the improvement of future atomic stations. The first 'breeder' reactor, as it is called, uses Uranium 235 as a fuel in the central core, which is surrounded by a blanket of Uranium 238. Enormous heat is produced by the fission of these two but, of greater importance, more fuel is formed in the blanket of Uranium 238 than is actually burned in the reactor core. This is one of the wonders of modern atomic science, and future possibilities are enormous. The heat produced in the reactor is used to produce steam in heat exchangers and to drive a single 15 million watt generator as an experiment, the electricity produced being used for all station supplies. Other types of reactors and chemical research stations are being built at Dounreay.

**KEY TO HOW IT OPERATES:** (1) The reactor core of Uranium 235, which produces enormous heat. (2) Surrounding blanket of Uranium 238. (3) Stainless steel vessel containing the circulating liquid metal. (4) Inner graphite shield to prevent radiation of neutrons. (5) Control rods, for closing down the reactor when necessary. (6) Charging door. (7) Uranium charging and discharging machines. (8) Liquid metal (sodium-potassium) circulating pump. (The liquid metal passes down through the reactor core and blanket, where it is heated, and passes out at the bottom; then it goes up through the first stage heat-exchanger. (9) Primary, (or first stage) heat-exchanger; here another liquid metal circuit passes downwards and is heated. (10) Heated liquid metal to secondary heat-exchanger house. (11) Cooled liquid metal from secondary heat-exchanger house. (12) Concrete vault containing the reactor, which is surrounded by 24 heat-exchangers. (13) Concrete shield preventing radiation. (14) Reactor cooling-air circulating fans. (15) Secondary liquid metal circulating pump. (16) Secondary heat exchanger; here the heated liquid metal circuit passes upwards, and heats the incoming water, which passes downwards and is turned into steam. (17) Water circuit from turbine condensers. (18) Steam drum. (19) Steam supply to turbine. (20) Steam turbine. (21) 15 million watt generator. (22) Turbine condenser; here the exhaust steam is condensed back into water, which is pumped back into the secondary heat-exchanger. (23) Condenser cooling-water control valves. (24) Condenser cooling-water inlet main from pump-house on the sea coast. (25) Sea-water outlet main to sea. (26) 11,000 volt cables to transformer house. (27) Transformer house, where the current is stepped down to 415 and 240 volts for distribution to all the buildings. (28) Cables to switchhouse and sub-stations. **KEY TO OTHER FEATURES:** (29) Stand-by Diesel generators, for all station needs in the event of supply failure. (30) Diesel-engine oil-store. (31) Steel sphere, 135 ft. in diameter. (32) Revolving gangway. (33) Goliath crane. (34) 25 ton hoist. (35) 7½ ton hoist. (36) Concrete foundation ring. (37) Crawl holes for access to lower sphere. (38) Electricity cables. (39) Air-lock, with doors either end. This is for bringing fuel elements from store. (40) Reactor cooling-air chimney. (41) Fuel-store building.

**PRINCIPLES OF THE PRIMARY HEAT-EXCHANGER:** The heated liquid metal circulates in the inner tube, and exchanges its heat with that circulating in the outer tube. In the secondary heat-exchanger, water circulates in the outer tube and becomes steam.





# BATTLE-CRUISER H.M.S. REPULSE

**KEY TO NUMBERED PARTS:** (1) Jackstaff, (2) Breakwater, (3) Forecastle deck, (4) Quarter deck, (5) Upper deck, (6) Main deck, (7) Lower deck, (8) Platform deck, (9) Two 15-inch guns in each of three turrets, (10) Barbette, (11) Range-finders in turrets, (12) Armoured conning tower, (13) Director, (14) Spotting top, (15) and (16) 4-inch Director platforms, (17) Upper bridge, (18) Searchlights, (19) Multiple machine-guns, (20) Triple 4-inch guns in shields, (21) Multiple pom-pom anti-aircraft guns, (22) 4-inch high-angle guns, (23) Spare seaplane floats, (24) and (25) Ship's boats stowed, (26) Aircraft cranes, (27) Aircraft hangars, (28) Athwartship catapult, (29) Tripod mainmast, (30) Quadruple screws, (31) Fixed 21-inch torpedo tubes in pairs, port and starboard, eight in all, (32) Wardroom, (33) Seamen's quarters, (34) Wash spaces, (35) Officers' quarters, (36) Auxiliary machinery, (37) Fresh water tanks, (38) Anti-torpedo bulge, (39) Boiler rooms, (40) Engine rooms, The engines developed 112,000 h.p. and were capable of driving the ship at about 29 knots, (41) Funnel cage. The purpose of this was to enable a painted canvas cover to be spread over the uptake, to prevent rain getting down into the interior when the furnaces were out; usually used when the ship was under refit.



Built at Clydebank in 1916, H.M.S. *Repulse* was a 'Renown' class ship with a displacement of 32,000 tons. Originally a modified battleship, she was re-designed as a battle-cruiser after the Falkland Islands' engagement of World War I.

Battle-cruisers were capital ships in which the main armament and armour were less than, and the speeds several knots faster than, the battleship. Now this type of vessel is considered extinct.

Despite powerful armament and heavy armour, these ships were vulnerable to determined attacks from the air. This was proved conclusively in the tragically brief engagement involving H.M.S. *Repulse* and H.M.S. *Prince of Wales* off Malaya in 1941, as related on the right.

## ACTION OFF MALAYA

Three days after Japan's attack on Pearl Harbour, which heralded her entry into World War II, Britain sustained a severe and bitter blow in the loss of two capital ships - H.M.S. *Prince of Wales* and the battle-cruiser *Repulse* off the coast of Malaya. The British squadron, under the command of Admiral Sir T. Phillips, comprising the flagship *Prince of Wales*, *Repulse* and four destroyers, sailed from Singapore at 5.35 p.m. on 8th December, 1941. Proceeding North in search of enemy transports, they were sighted by a Japanese submarine at 2 p.m. on the 9th (A). Enemy aircraft were sighted at 6.35 p.m., and the squadron turned to port (B). Considerable air activity being reported, the ships turned again (C) at 8.15 p.m. and steamed South. Just before midnight, the flagship received an 'Immediate' signal, giving news of a large enemy landing-force near Kuantan and Admiral Phillips headed the ships in that direction (D). At 6.0 a.m. on 10th December, they were at point (E). Meanwhile, a Japanese striking force of some 30 bombers and 50 torpedo-bombers was searching for the British squadron. On their southward run (F) from their base in Indo-China, the aircraft failed to sight their quarry but, by ill-luck, found it on the return journey. At 8.0 a.m., the ships were at point (G). Soon after 11.0 a.m. on the 10th, the attack was started, first by high-level bombers and then by torpedo-bombers. *Repulse* was hit in the first attack, but not severely damaged. Minutes later, *Prince of Wales* was out of control, having been struck by two torpedoes. Four more torpedoes blasted their way into the stricken vessel in quick succession, and *Repulse's* steering-gear was jammed in yet another torpedo-bomber attack, leaving her at the mercy of the relentless Japanese airmen, who continued to rain blows upon her. She hung for several minutes with a list of about 60 to 70 degrees to port, then rolled over and sank at 12.33 p.m. (X). Destroyers picked up 796 officers and men of her company. The *Prince of Wales*, meanwhile, continued to steam slowly, but she was settling in the water rapidly and was clearly doomed. At approximately 1.20 p.m. she heeled over, turned turtle and sank. Of her complement of 1,612, destroyers rescued 1,285.



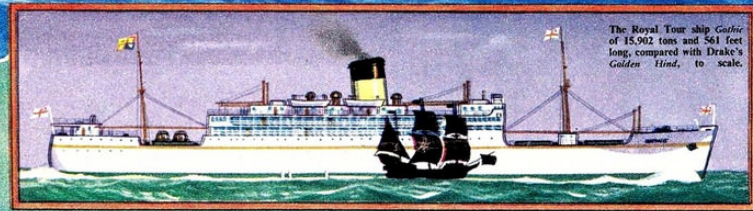
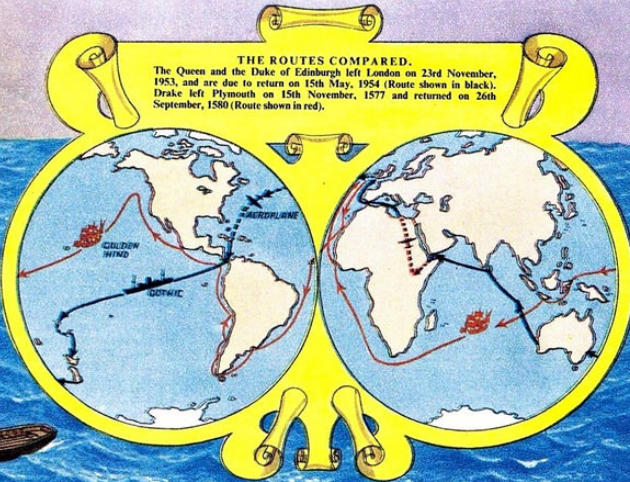
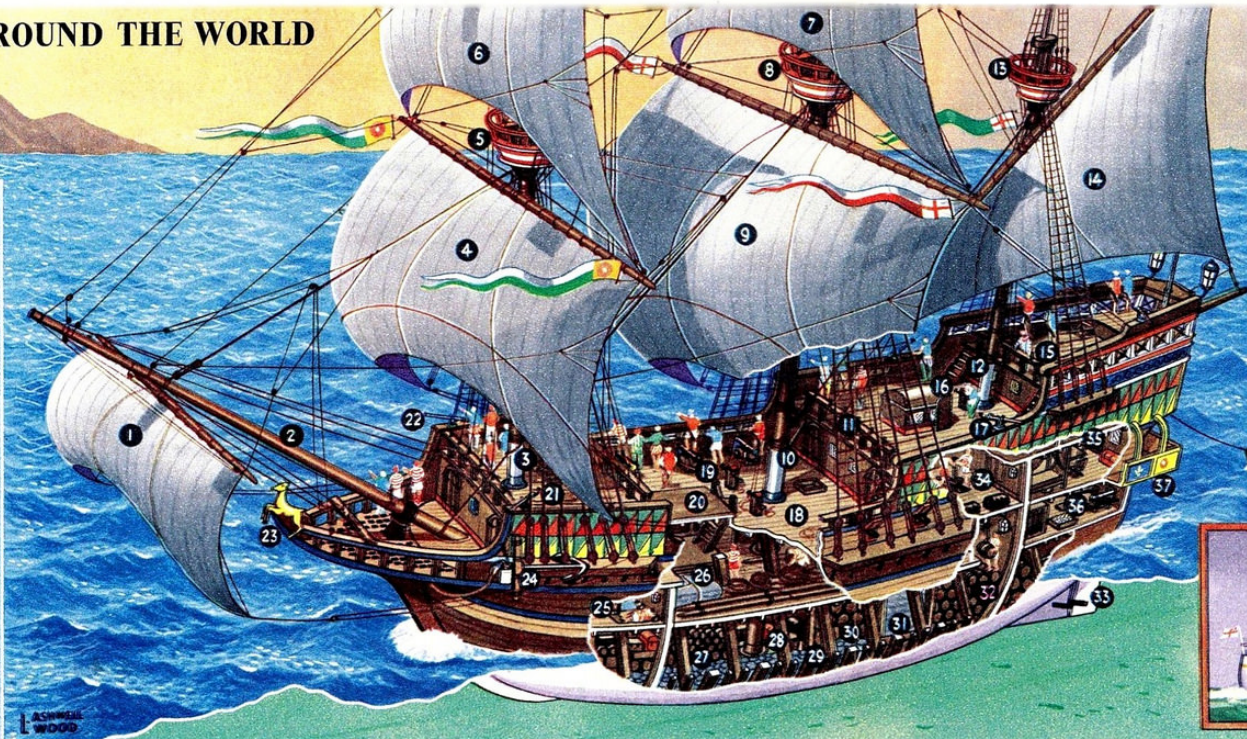


# DRAKE GOES ROUND THE WORLD

When Queen Elizabeth arrives back in London next week from the Royal Tour, she will be the first British Sovereign to circumnavigate the world. An interesting comparison is made on these pages with Sir Francis Drake, who was the first Englishman to do the same, in his wonderful little vessel the *Golden Hind* in 1580, just 374 years previously. The *Golden Hind*, as reconstructed here from the most authentic information available, was a ship of only 100 tons, 60 feet long on the water line, with a beam of 19 feet. She carried a crew of 85. When the Queen sails up London's River upon her return, she will pass Deptford, the very place where Sir Francis Drake was knighted on board his ship by the first Queen Elizabeth, and where his *Golden Hind* was preserved in dry dock for nearly a hundred years.

**KEY TO SAILS AND RIGGING.**  
(1) Spritsail. (2) Bowsprit. (3) Fore mast. (4) Fore course. (5) Fore top. (6) Fore topsail. (7) Main topsail. (8) Main course. (9) Main mast. (11) Main shrouds. (12) Mizzen mast. (13) Mizzen top. (14) Mizzen sail.

**KEY TO HULL.**  
(15) Quarter deck, from where Drake gave his orders. (16) Great sky light. (17) Falconer's or swivel guns. (18) Main or gun deck. (19) Cast iron 4 in. guns. Six each side. (20) Great hatch. (21) Forecastle. (22) Bow chaser swivel guns. (23) *Golden Hind* figure-head. (24) Cathead and starboard anchor. (25) Crew space. They slept when and where they could. (26) Lower deck for spare spars, sails, cables, etc. (27) General stores and cargo. Ballast of stones underneath. (28) Diagonal timber bracing, typical of Elizabethan ships. (29) Main ribs with outer planking. (30) Fresh water in barrels. (31) Flour store. (32) Powder magazine and safety lantern. (33) Rudder. (34) Whip-staff for steering. Orders were shouted down from above. (35) Drake's Great cabin. (36) Stern saker gun and steering tiller. (37) Stern gallery from Great cabin. (38) Ship's boat towed astern. It was stowed on top of Great hatch.



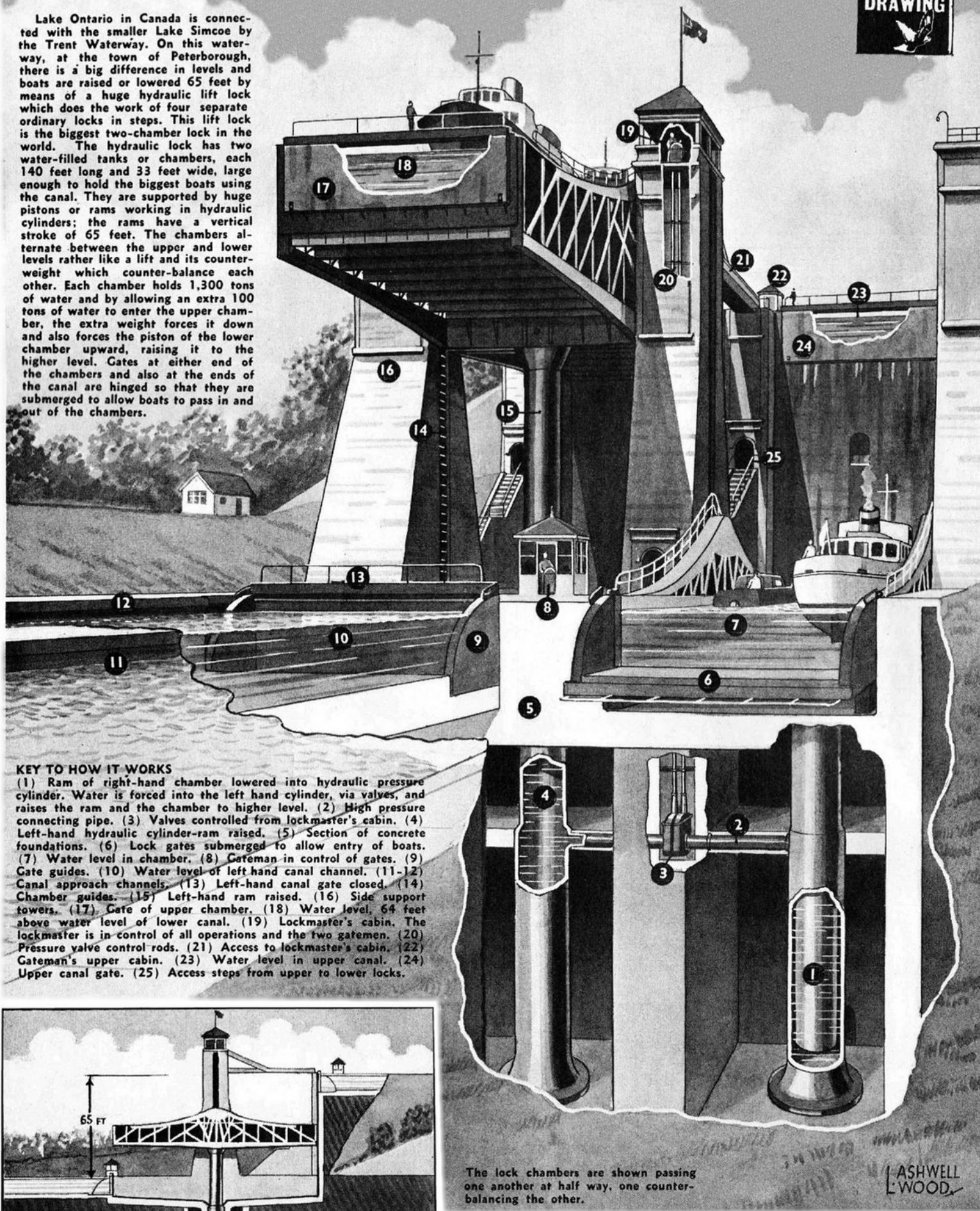
ASHMOL WOOD



# WATERWAY IN THE SKY



Lake Ontario in Canada is connected with the smaller Lake Simcoe by the Trent Waterway. On this waterway, at the town of Peterborough, there is a big difference in levels and boats are raised or lowered 65 feet by means of a huge hydraulic lift lock which does the work of four separate ordinary locks in steps. This lift lock is the biggest two-chamber lock in the world. The hydraulic lock has two water-filled tanks or chambers, each 140 feet long and 33 feet wide, large enough to hold the biggest boats using the canal. They are supported by huge pistons or rams working in hydraulic cylinders; the rams have a vertical stroke of 65 feet. The chambers alternate between the upper and lower levels rather like a lift and its counter-weight which counter-balance each other. Each chamber holds 1,300 tons of water and by allowing an extra 100 tons of water to enter the upper chamber, the extra weight forces it down and also forces the piston of the lower chamber upward, raising it to the higher level. Gates at either end of the canal are hinged so that they are submerged to allow boats to pass in and out of the chambers.



## KEY TO HOW IT WORKS

(1) Ram of right-hand chamber lowered into hydraulic pressure cylinder. Water is forced into the left hand cylinder, via valves, and raises the ram and the chamber to higher level. (2) High pressure connecting pipe. (3) Valves controlled from lockmaster's cabin. (4) Left-hand hydraulic cylinder-ram raised. (5) Section of concrete foundations. (6) Lock gates submerged to allow entry of boats. (7) Water level in chamber. (8) Gateman in control of gates. (9) Gate guides. (10) Water level of left hand canal channel. (11-12) Canal approach channels. (13) Left-hand canal gate closed. (14) Chamber guides. (15) Left-hand ram raised. (16) Side support towers. (17) Gate of upper chamber. (18) Water level, 64 feet above water level of lower canal. (19) Lockmaster's cabin. The lockmaster is in control of all operations and the two gatemen. (20) Pressure valve control rods. (21) Access to lockmaster's cabin. (22) Gateman's upper cabin. (23) Water level in upper canal. (24) Upper canal gate. (25) Access steps from upper to lower locks.

The lock chambers are shown passing one another at half way, one counter-balancing the other.

LASHWELL  
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# WORLD'S LARGEST DRY DOCK

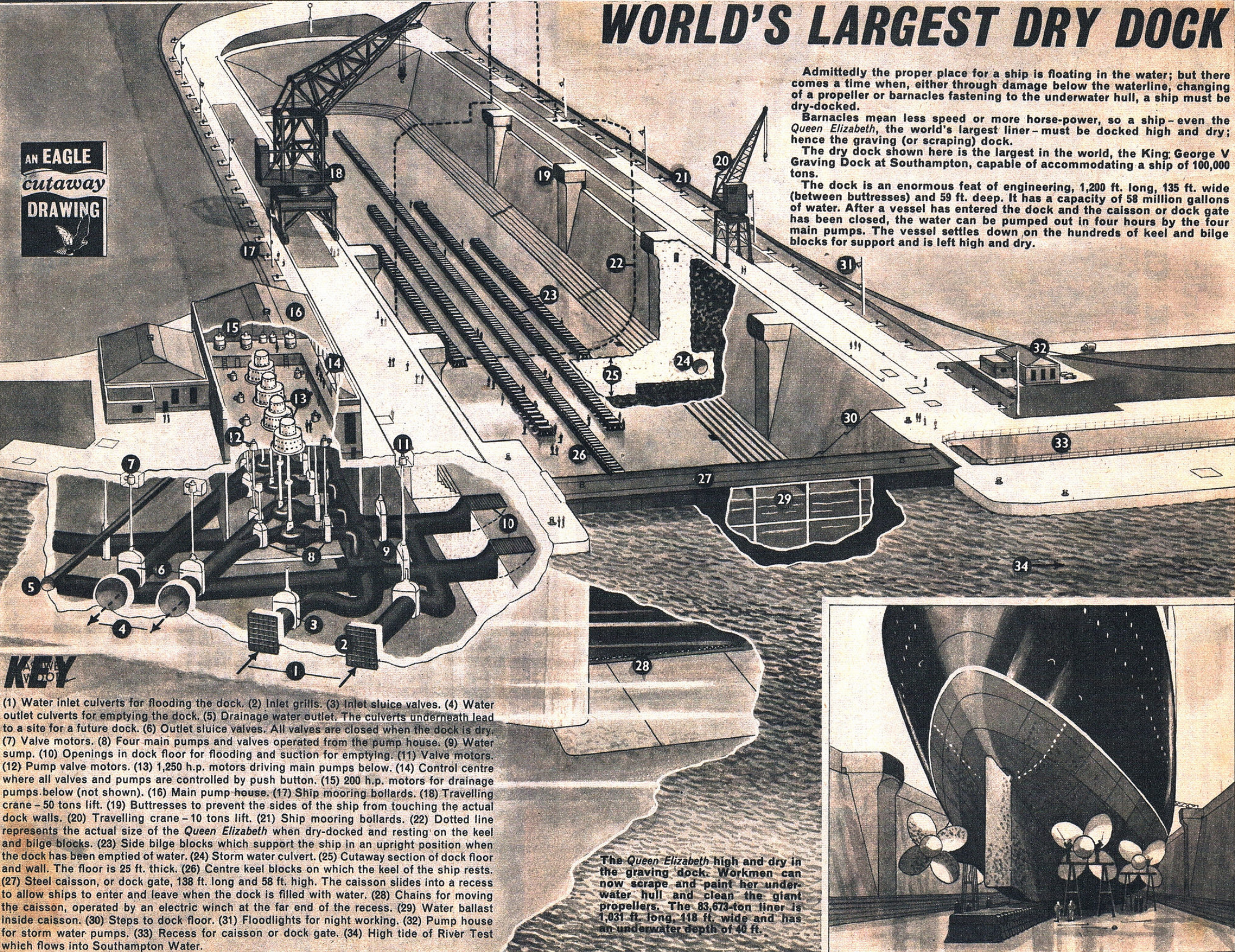


Admittedly the proper place for a ship is floating in the water; but there comes a time when, either through damage below the waterline, changing of a propeller or barnacles fastening to the underwater hull, a ship must be dry-docked.

Barnacles mean less speed or more horse-power, so a ship—even the *Queen Elizabeth*, the world's largest liner—must be docked high and dry; hence the graving (or scraping) dock.

The dry dock shown here is the largest in the world, the King George V Graving Dock at Southampton, capable of accommodating a ship of 100,000 tons.

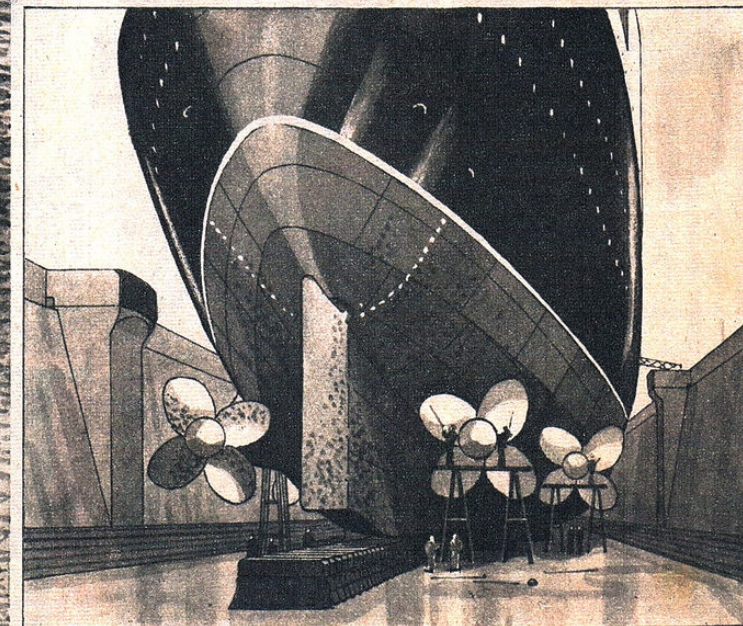
The dock is an enormous feat of engineering, 1,200 ft. long, 135 ft. wide (between buttresses) and 59 ft. deep. It has a capacity of 58 million gallons of water. After a vessel has entered the dock and the caisson or dock gate has been closed, the water can be pumped out in four hours by the four main pumps. The vessel settles down on the hundreds of keel and bilge blocks for support and is left high and dry.



## KEY

(1) Water inlet culverts for flooding the dock. (2) Inlet grills. (3) Inlet sluice valves. (4) Water outlet culverts for emptying the dock. (5) Drainage water outlet. The culverts underneath lead to a site for a future dock. (6) Outlet sluice valves. All valves are closed when the dock is dry. (7) Valve motors. (8) Four main pumps and valves operated from the pump house. (9) Water sump. (10) Openings in dock floor for flooding and suction for emptying. (11) Valve motors. (12) Pump valve motors. (13) 1,250 h.p. motors driving main pumps below. (14) Control centre where all valves and pumps are controlled by push button. (15) 200 h.p. motors for drainage pumps below (not shown). (16) Main pump house. (17) Ship mooring bollards. (18) Travelling crane—50 tons lift. (19) Buttresses to prevent the sides of the ship from touching the actual dock walls. (20) Travelling crane—10 tons lift. (21) Ship mooring bollards. (22) Dotted line represents the actual size of the *Queen Elizabeth* when dry-docked and resting on the keel and bilge blocks. (23) Side bilge blocks which support the ship in an upright position when the dock has been emptied of water. (24) Storm water culvert. (25) Cutaway section of dock floor and wall. The floor is 25 ft. thick. (26) Centre keel blocks on which the keel of the ship rests. (27) Steel caisson, or dock gate, 138 ft. long and 58 ft. high. The caisson slides into a recess to allow ships to enter and leave when the dock is filled with water. (28) Chains for moving the caisson, operated by an electric winch at the far end of the recess. (29) Water ballast inside caisson. (30) Steps to dock floor. (31) Floodlights for night working. (32) Pump house for storm water pumps. (33) Recess for caisson or dock gate. (34) High tide of River Test which flows into Southampton Water.

The *Queen Elizabeth* high and dry in the graving dock. Workmen can now scrape and paint her underwater hull and clean the giant propellers. The 83,673-ton liner is 1,031 ft. long, 118 ft. wide and has an underwater depth of 40 ft.





# A FLYING CRANE

## THE 16-TON 'WESTMINSTER' HELICOPTER



How the big *Westminister* will appear when used as a 40-46 seat passenger helicopter.

The Westland *Westminister* is one of the largest helicopters built in this country. Its massive steel-tube girder construction makes it suitable for weight-lifting (as a flying crane) or for transport work. Another version will be a 40-46 seat passenger type.

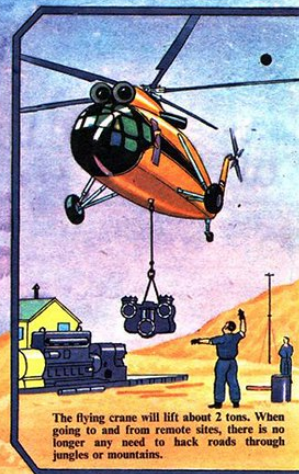
This great helicopter is powered by two Napier *Eland* jet engines of 3,500 shaft horse-power each, coupled to a final drive gearbox for driving the five huge 72 ft.-diameter main rotor blades. The cruising speed is 150 m.p.h., with a range of 100 miles at full load.

Overall fuselage length is 86 ft. 9 ins., and the rotor head is 18 ft. 4 ins. from the ground. Vertical rate of climb is 1,200 ft. per minute. As a flying crane version, the *Westminister* will be able to lift about 2 tons.

**KEY TO HOW IT WORKS:** (1) Air intakes to the two Napier *Eland* jet engines - 3,500 h.p. each. (2) Air compressor. (3) Combustion chambers and turbine wheel casing. (4) Starboard jet exhaust pipe. (5) Clutch and reduction gearbox (each engine). (6) Main drive gearbox. (7) Bevel drive to tail rotor. (8) Epicyclic change speed gearbox. (9) Main rotor shaft and flying control links, for altering the pitch and tilt of the rotor blades. (10) Main rotor head. (11) One of five 72 ft.-diameter main rotor blades. According to their angle, these give the lift, and forwards or sideways movement, of the helicopter. (12) Tail rotor drive. (13) Intermediate gearbox. (14) Tail rotor gearbox. (15) 15 ft.-diameter tail rotor blades. These act as a rudder, right or left, according to their

angle of pitch. (16) Tail rotor pitch control. (17) Pitch control quadrant.

**KEY TO OTHER PARTS:** (18) Tail-wheel spring suspension. (19) Very strong welded steel-tube girder fuselage. (20-21) Fuel tanks - 250 gallons of kerosene each. (22) Belt-driven oil cooling fans. (23) Hydraulic pressure controls for the various pumps, etc. (24) Radio and electrical case. (25) Strong steel-tube load-carrier. (26) Flying crane load-carrying point. (27) Air and hydraulic undercarriage strut. (28) Flying control selector-box. (29) Fuel transfer tank. (30) Flying and engine controls from cockpit. (31) Pilots' control column (dual control each side). (32) Rudder pedals (tail rotor). (33) Instrument panel.



The flying crane will lift about 2 tons. When going to and from remote sites, there is no longer any need to hack roads through jungles or mountains.

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JOHN S. SMITH

## A DREDGING OPERATION

1. Lifting gear for raising or lowering bucket girder to required depth.
2. Derrick
3. Buckets empty into chute
4. Twin funnels abreast
5. Chute for emptying mud into barge
6. Continuous chain of buckets
7. Mooring cable
8. Mudbank required to be dredged
9. Barge into which mud is emptied.
10. Secondary barge
11. Tug which tows loaded barges to disposal area.
12. Ship using dredged channel
13. Ship must keep to inside of buoy which marks channel



# GRUMMAN/PICCARD PX-15



The 130-ton PX-15 will shelter six men for six weeks during an underwater voyage of exploration up the Gulf Stream. Panels of lithium hydroxide (CO<sub>2</sub> scrubbers) remove carbon dioxide from air while oxygen is replenished from storage tanks. Special thermos-like tanks will maintain hot water; it will be used for heating food and bathing. Conning tower and battery compartment are open to sea (oil is added to batteries to keep water out). Piloting the vessel underwater will be done from control console incorporating TV screen, sonar, and other sensors. Four 25-hp. AC motors propel sub when not drifting, running in either direction at any speed. Each motor housing is rotatable for additional control. A transparent biological sampler connecting two portholes will give explorers a constant view of marine life. In the event of emergency, iron shot (top) is released, bringing sub up.

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Popular Science Monthly



An A-4 Class, 3-cylinder, 4-6-2 Pacific Locomotive hauling the up train from Edinburgh to London passing "Across the Border" near Berwick. This drawing completes our series of the four main line expresses. New Locomotives being built for British Railways will be published as they appear.

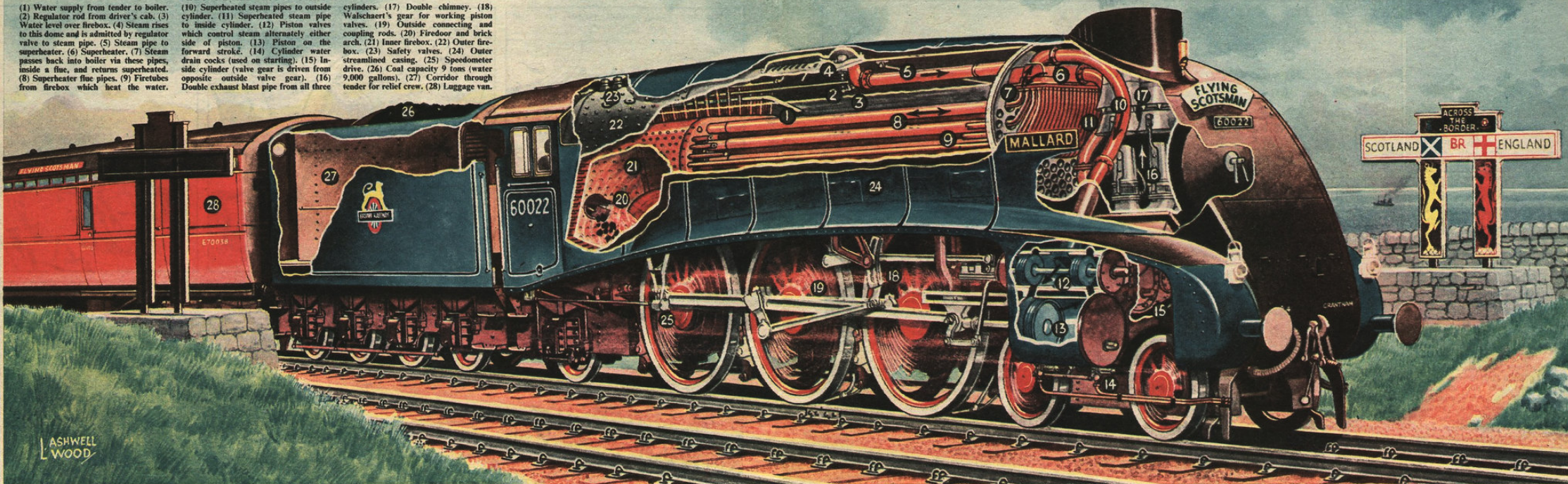
#### KEY TO HOW IT WORKS

(1) Water supply from tender to boiler.  
(2) Regulator rod from driver's cab.  
(3) Water level over firebox. (4) Steam rises to this dome and is admitted by regulator valve to steam pipe. (5) Steam pipe to superheater. (6) Superheater. (7) Steam passes back into boiler via these pipes, inside a flue, and returns superheated.  
(8) Superheater flue pipes. (9) Firetubes from firebox which heat the water.

(10) Superheated steam pipes to outside cylinder. (11) Superheated steam pipe to inside cylinder. (12) Piston valves which control steam alternately either side of piston. (13) Piston on the forward stroke. (14) Cylinder water drain cocks (used on starting). (15) Inside cylinder (valve gear is driven from opposite outside valve gear). (16) Double exhaust blast pipe from all three

cylinders. (17) Double chimney. (18) Walschaert's gear for working piston valves. (19) Outside connecting and coupling rods. (20) Firedoor and brick arch. (21) Inner firebox. (22) Outer firebox. (23) Safety valves. (24) Outer streamlined casing. (25) Speedometer drive. (26) Coal capacity 9 tons (water 9,000 gallons). (27) Corridor through tender for relief crew. (28) Luggage van.

## A FAMOUS BRITISH EXPRESS—THE "FLYING SCOTSMAN"





# A MODERN RACING JET-AIRCRAFT

This top-ranking single-seater racer won the first prize in a design competition organized by the Royal Aero Club, and was designed at the Ministry of Supply, Boscombe Down, Wiltshire. It has a small jet engine called the Blackburn Turbomeca *Palas* with a thrust of 300 lb. The fuselage and wings are built entirely of wood, spruce being used for the spars, ribs and frames, with an outer cover of 5/32 in. plywood. The fuselage is designed in three separate sections, the nose section containing the nose wheel, controls and cockpit, the centre section containing the engine, fuel tanks and main undercarriage wheels. The rear fuselage and tail section consist of the tail plane with fins and rudders.

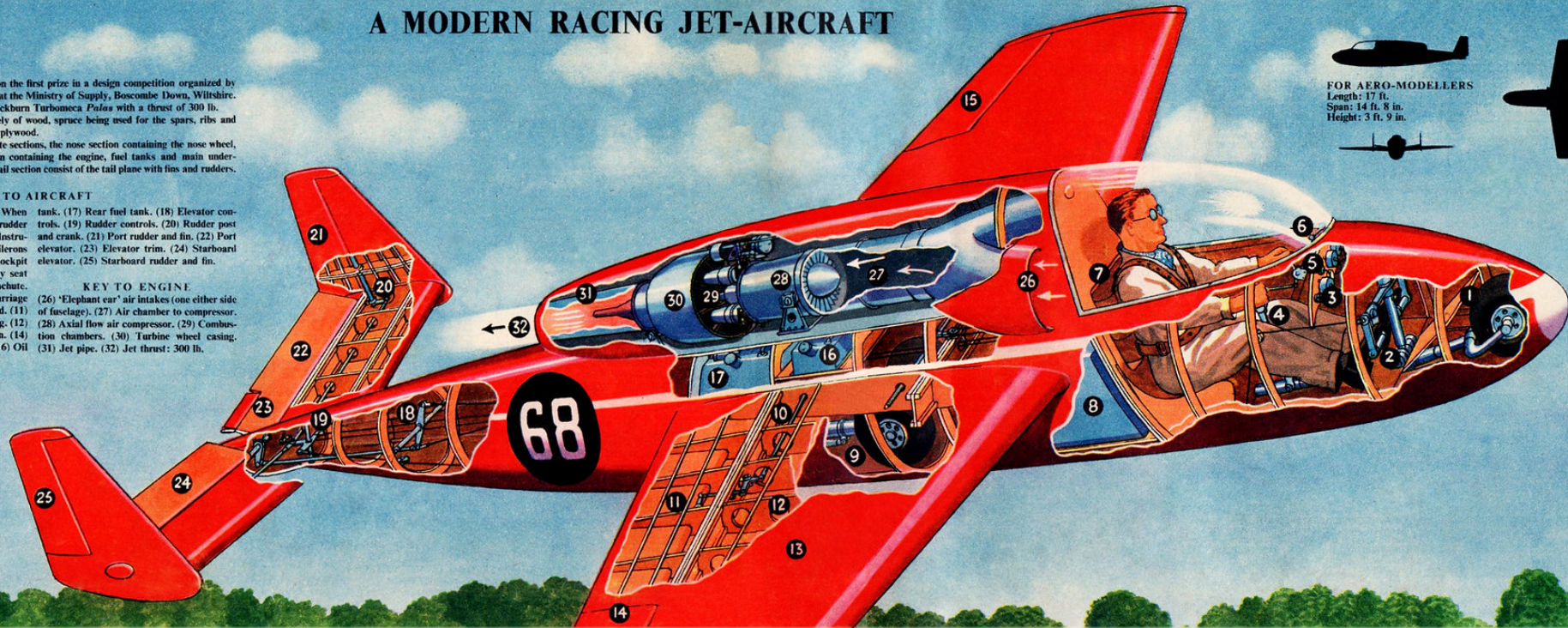
## KEY TO AIRCRAFT

(1) Steerable nose wheel (retracted). When lowered steering is controlled by the rudder bar. (2) Hanging rudder pedals. (3) Instrument panel. (4) Control column for ailerons and elevators. (5) Engine throttle. (6) Cockpit canopy release catch. (7) Moulded ply seat with recess for pilot's back-type parachute. (8) Front fuel tank. (9) Main undercarriage wheels (retracted). (10) Flap control rod. (11) Simple split flap, for take-off and landing. (12) Spruce ribs. (13) 5/32 in. plywood skin. (14) Starboard aileron. (15) Port aileron. (16) Oil tank. (17) Rear fuel tank. (18) Elevator controls. (19) Rudder controls. (20) Rudder post and crank. (21) Port rudder and fin. (22) Port elevator. (23) Elevator trim. (24) Starboard elevator. (25) Starboard rudder and fin.

## KEY TO ENGINE

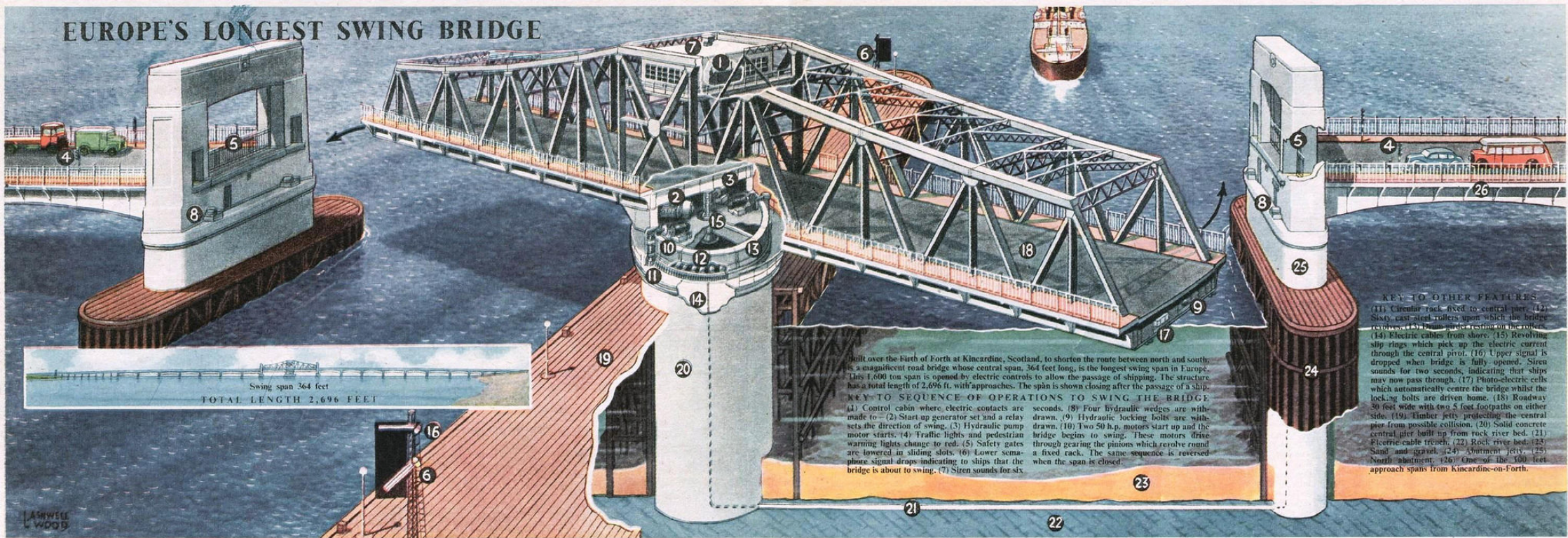
(26) 'Elephant ear' air intakes (one either side of fuselage). (27) Air chamber to compressor. (28) Axial flow air compressor. (29) Combustion chambers. (30) Turbine wheel casing. (31) Jet pipe. (32) Jet thrust: 300 lb.

FOR AERO-MODELLERS  
Length: 17 ft.  
Span: 14 ft. 8 in.  
Height: 3 ft. 9 in.





# EUROPE'S LONGEST SWING BRIDGE



Built over the Firth of Forth at Kincardine, Scotland, to shorten the route between north and south, is a magnificent road bridge whose central span, 364 feet long, is the longest swing span in Europe. This 1,600 ton span is opened by electric controls to allow the passage of shipping. The structure has a total length of 2,696 ft. with approaches. The span is shown closing after the passage of a ship.

## KEY TO SEQUENCE OF OPERATIONS TO SWING THE BRIDGE

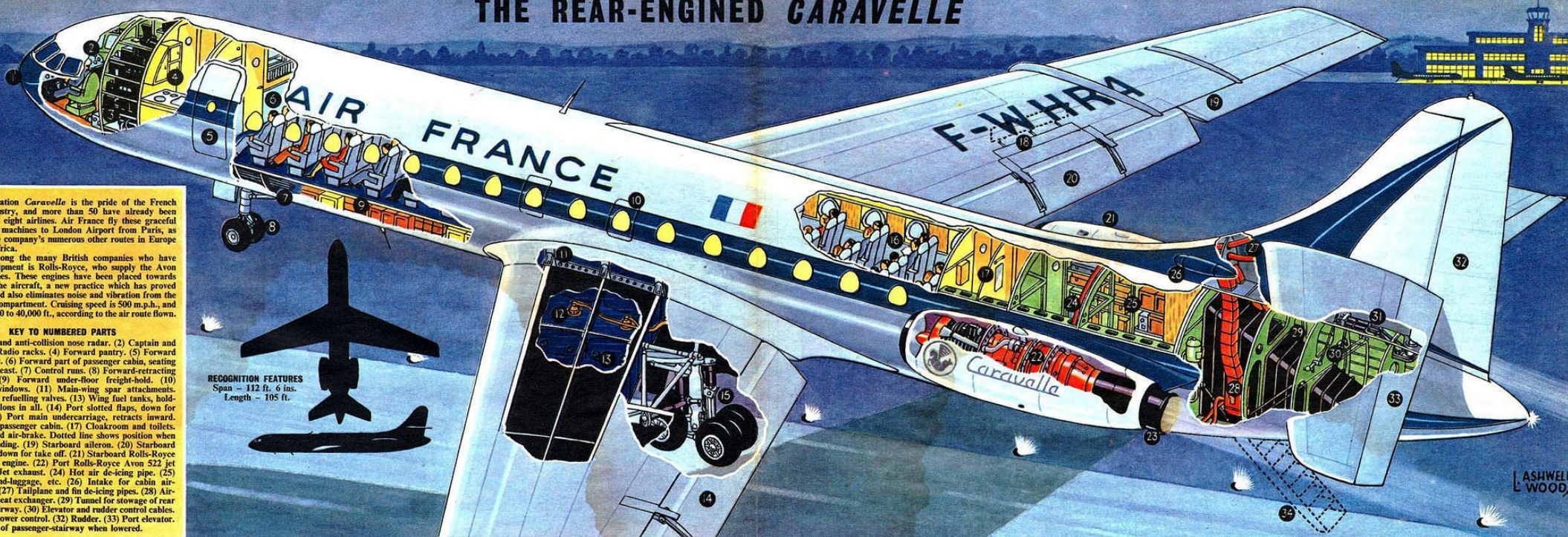
(1) Control cabin where electric contacts are made to— (2) Start up generator set and a relay sets the direction of swing. (3) Hydraulic pump motor starts. (4) Traffic lights and pedestrian warning lights change to red. (5) Safety gates are lowered in sliding slots. (6) Lower semaphore signal drops indicating to ships that the bridge is about to swing. (7) Siren sounds for six seconds. (8) Four hydraulic wedges are withdrawn. (9) Hydraulic locking bolts are withdrawn. (10) Two 50 h.p. motors start up and the bridge begins to swing. These motors drive through gearing the pinions which revolve round a fixed rack. The same sequence is reversed when the span is closed.

## KEY TO OTHER FEATURES

(11) Circular rock fixed to central pier. (12) Sixty cast steel rollers upon which the bridge revolves. (13) Drum-pulley resting on the rollers. (14) Electric cables from shore. (15) Revolving slip rings which pick up the electric current through the central pivot. (16) Upper signal is dropped when bridge is fully opened. Siren sounds for two seconds, indicating that ships may now pass through. (17) Photo-electric cells which automatically centre the bridge whilst the locking bolts are driven home. (18) Roadway 30 feet wide with two 5 feet footpaths on either side. (19) Timber jetty protecting the central pier from possible collision. (20) Solid concrete central pier built up from rock river bed. (21) Electric cable trench. (22) Rock river bed. (23) Sand and gravel. (24) Abutment jetty. (25) North abutment. (26) One of the 100 feet approach spans from Kincardine-on-Forth.



# THE REAR-ENGINEED CARAVELLE



The Sud-Aviation *Caravelle* is the pride of the French Aircraft industry, and more than 50 have already been purchased by eight airlines. Air France fly these graceful 80-passenger machines to London Airport from Paris, as well as on the company's numerous other routes in Europe and North Africa.

The first among the many British companies who have provided equipment is Rolls-Royce, who supply the Avon 522 jet engines. These engines have been placed towards the rear of the aircraft, a new practice which has proved successful, and also eliminates noise and vibration from the passengers' compartment. Cruising speed is 500 m.p.h., and altitude 20,000 to 40,000 ft., according to the air route flown.

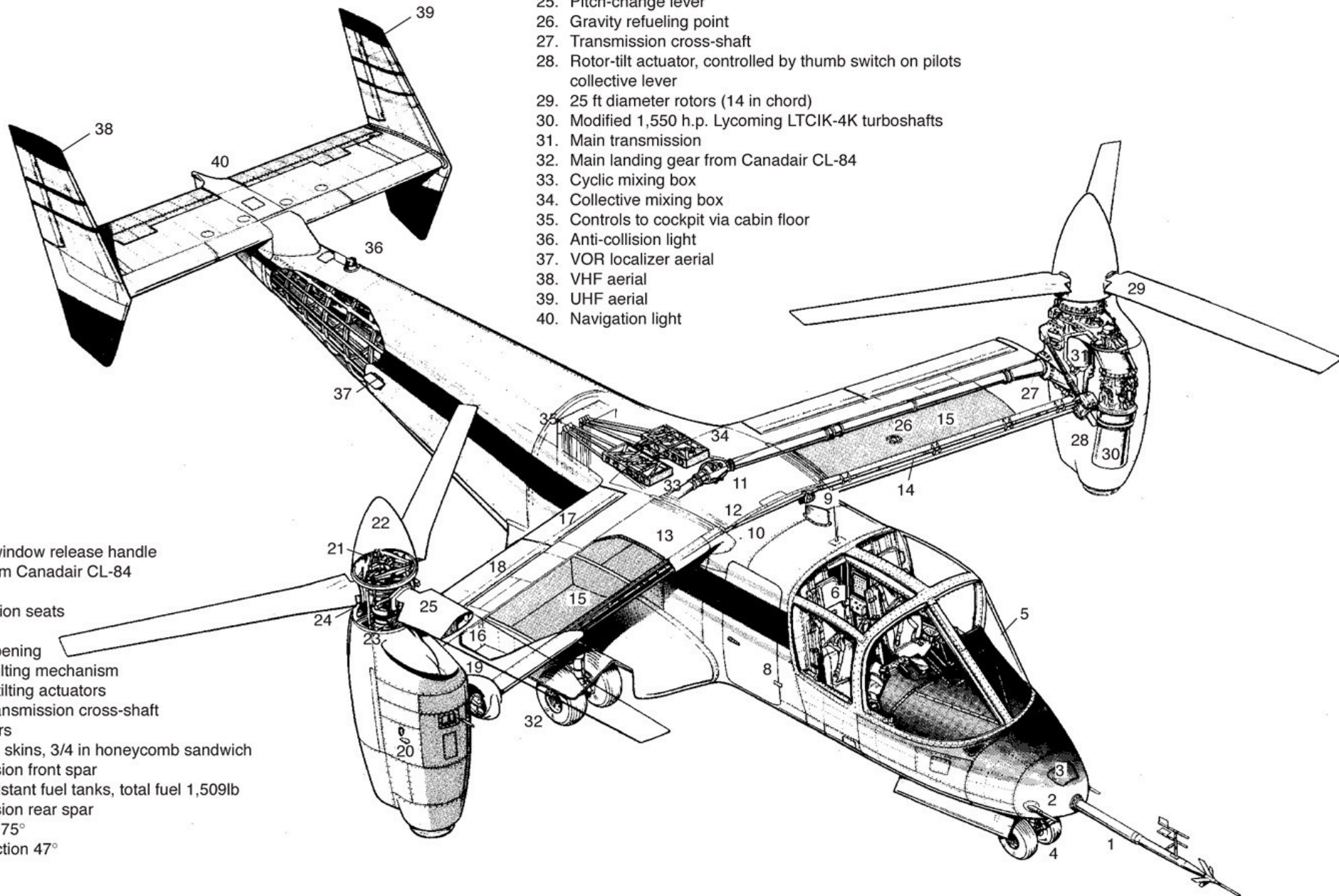
## KEY TO NUMBERED PARTS

(1) Weather and anti-collision nose radar. (2) Captain and co-pilot. (3) Radio racks. (4) Forward pantry. (5) Forward entrance door. (6) Forward part of passenger cabin, seating 80 at five abreast. (7) Control runs. (8) Forward-retracting nosewheels. (9) Forward under-floor freight-hold. (10) Emergency windows. (11) Main-wing spar attachments. (12) Pressure refuelling valves. (13) Wing fuel tanks, holding 4,100 gallons in all. (14) Port slotted flaps, down for take off. (15) Port main undercarriage, retracts inward. (16) Rear of passenger cabin. (17) Cloakroom and toilets. (18) Starboard air-brake. Dotted line shows position when raised for landing. (19) Starboard aileron. (20) Starboard slotted flaps, down for take off. (21) Starboard Rolls-Royce Avon 522 jet engine. (22) Port Rolls-Royce Avon 522 jet engine. (23) Jet exhaust. (24) Hot air de-icing pipe. (25) Hold for hand-luggage, etc. (26) Intake for cabin air-conditioning. (27) Tailplane and fin de-icing pipes. (28) Air-conditioning heat exchanger. (29) Tunnel for stowage of rear passenger-stairway. (30) Elevator and rudder control cables. (31) Rudder power control. (32) Rudder. (33) Port elevator. (34) Position of passenger-stairway when lowered.

**RECOGNITION FEATURES**  
Span - 112 ft. 6 ins.  
Length - 105 ft.

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1. Instrument boom
2. Pitot static probe
3. Door for emergency window release handle
4. Nose landing gear from Canadair CL-84
5. Bird-proof windshield
6. Rockwell LW-3B ejection seats
7. Avionics installation
8. Entry door, 2 ft 8 in opening
9. Phasing actuator for tilting mechanism
10. Cross-shaft between tilting actuators
11. Center gearbox for transmission cross-shaft
12. Bonded splice doublers
13. Upper and lower wing skins, 3/4 in honeycomb sandwich
14. Aluminum alloy extrusion front spar
15. Lightweight crash-resistant fuel tanks, total fuel 1,509lb
16. Aluminum alloy extrusion rear spar
17. Flaps, max deflection 75°
18. Flaperons, max deflection 47°
19. Actuator fairing
20. Navigation lights
21. Collective-pitch lever
22. Collective crosshead

23. Cyclic swash plate
24. Cyclic tube
25. Pitch-change lever
26. Gravity refueling point
27. Transmission cross-shaft
28. Rotor-tilt actuator, controlled by thumb switch on pilots collective lever
29. 25 ft diameter rotors (14 in chord)
30. Modified 1,550 h.p. Lycoming LTCIK-4K turboshafts
31. Main transmission
32. Main landing gear from Canadair CL-84
33. Cyclic mixing box
34. Collective mixing box
35. Controls to cockpit via cabin floor
36. Anti-collision light
37. VOR localizer aerial
38. VHF aerial
39. UHF aerial
40. Navigation light



# AN OIL BURNING LOCOMOTIVE



Here is an amazing railway scene at the spiral tunnels in the Rocky Mountains near Yoho on the Canadian Pacific Railway. The locomotive on the left is actually pushing the tail of a 96-car freight train 50 feet below the front section above. The greater part of the train is inside the two-thirds of a mile long spiral tunnel No. 2. In less than a mile, by means of two spiral tunnels shown in the map inset, the railway reverses itself twice and drops 98 feet on the westward run to the Pacific Coast.

The giant streamlined oil-burning locomotive, shown climbing the eastward run to Montreal, is a two cylinder 2-10-4 Selkirk class, 98 feet long, and is the latest of a class that are the largest in the British Empire. They are designed for service through the Rocky Mountains between Calgary and Revelstoke. The flag denotes a "special" train.

## KEY TO NUMBERS

(1) Firebox with burners for oil fuel firing.  
(2) Fire arch water tubes. (3) Water level.  
(4) Steam rises to steam pipe. (5) Superheater. (6) Driver's regulator. (7) Fire-tubes and superheater flues. (8) Superheated steam pipes to cylinders. (9) Piston

valves which control steam either side of piston. (10) Piston on backward stroke. (11) Exhaust blast pipe from cylinders. (12) Feed water tanks heated by exhaust steam. (13) Pre-heated water supply valves to boiler. (14) Whistle. (15) Streamlined outer casing over boiler casing. (16) Electric headlamp. (17) Automatic coupling.

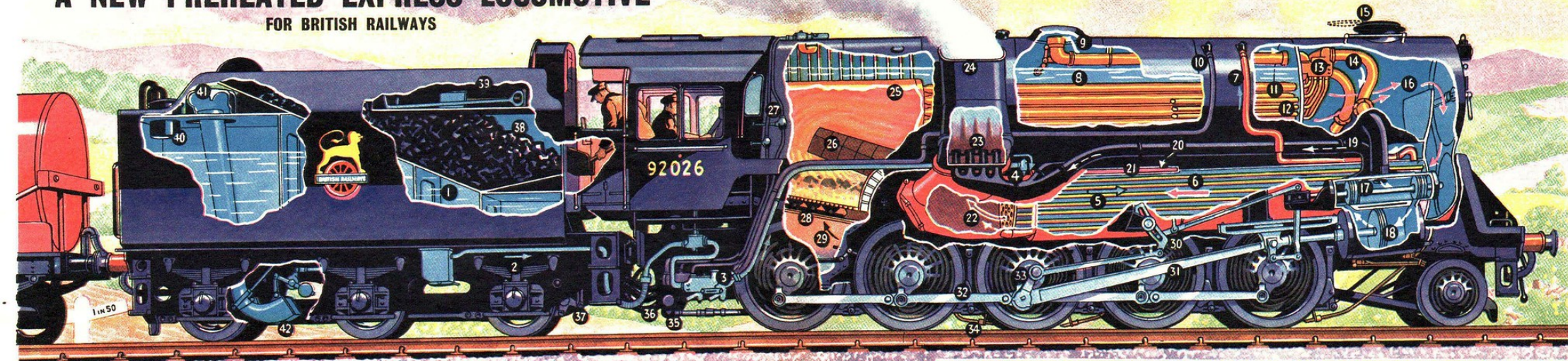
(18) Walschaerts gear working piston valves. (19) Reversing gear connected to driver's cab. (20) Connecting and coupling rods. (21) Compressors for air brakes. (22) Safety valves. (23) Warning bell. (24) Electricity generator. (25) Oil fuel capacity 3,500 gallons. (26) Water capacity 12,000 gallons.

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# A NEW PREHEATED EXPRESS LOCOMOTIVE

## FOR BRITISH RAILWAYS



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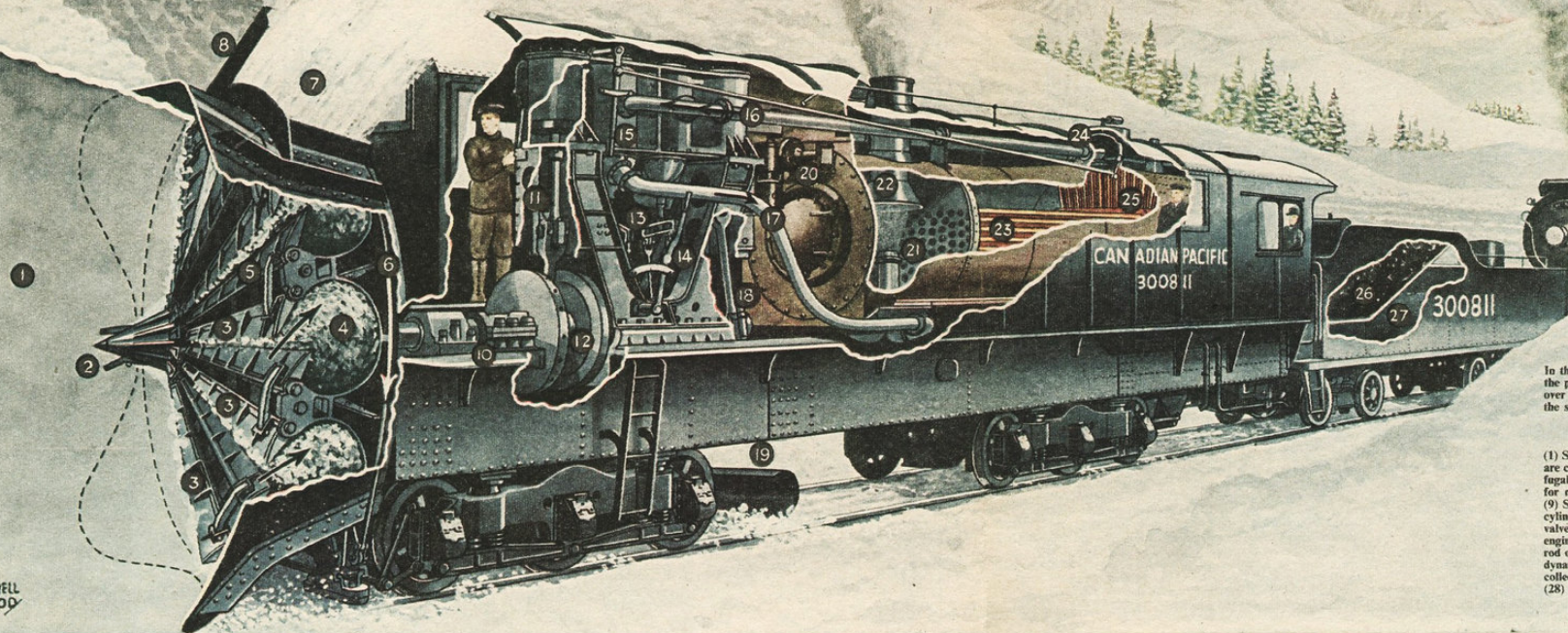
How many of you railway enthusiasts have spotted one of these unusual locomotives, with the exhaust coming out of the side instead of through the usual chimney? Ten of them are being built by British Railways; they are the Class 9, 2-10-0 Heavy Freight Express locomotives, fitted with a special preheating boiler underneath. In simplified terms, the locomotive works on the usual principle, but the normal chimney on the

**KEY TO HOW IT WORKS:** (1) Tender water capacity: 4,725 gallons. (2) Cold water supply to injectors. (3) Injectors operated by boiler steam and exhaust steam; either forces the cold water through the preheater and injects it into the boiler. (4) Water supply to preheater. (5) Water passing through the preheater. (6) Hot gases from firebox preheating the water supply. (7) Hot water from preheater to main boiler, where it is quickly turned into steam. (8) Hot water level in boiler and over firebox. (9) Steam supply to steam pipe through the driver's regulating valve. (10) Normal cold water supply to boiler for starting up. (11) Superheater flue tubes. (12) Fire tubes from firebox. (13) Superheater. (14) Superheated steam pipes to cylinders. (15) Chimney closed. It is opened, for starting up only, by a flap. (16) Hot gases from firebox passing to preheater. (17) Piston valves regulating supply of steam to cylinder. (18) Piston on the backward

stroke. (19) Exhaust steam pipe. (20) A portion of the exhaust steam circulates round the preheater. (21) Preheater steam-jacket. (22) Hot gases and steam-jacket exhaust to final chimney. (23) Exhaust steam blast-pipe nozzles; these draw the hot gases through the main boiler and preheater. (24) Final chimney. (25) Inner firebox. (26) Brick arch. (27) Injector steam-control valves. (28) Rocking fire-grate. (29) Draught air to fire. (30) Piston-valve control-link. (31) Connecting rod to driving wheel. (32) Coupling rods to coupled wheels. (33) Return crank, operating piston-valve link. (34) Driving wheel sand-pipes. (35) Locomotive steam-brake. (36) Flexible couplings for water supply (both sides), train vacuum-brake and carriage steam-heating. (37) Tender steam-brake. (38) Coal capacity: 10 tons. (39) Tool tunnel. (40) Water filler. (41) Water pick-up dome. (42) Water pick-up scoop (raised).



# A ROTARY SNOW-PLOUGH IN ACTION



In the Canadian Rockies, heavy falls of snow form in the railway cuttings. The vanes of the plough in front revolve at sufficient speed to throw snow well clear of the track, high over the embankment at the side. The vanes are reversible, so that, as the plough advances, the snow can be thrown either to right or to left. The plough is pushed to the scene of action by powerful locomotives.

## KEY TO NUMBERS

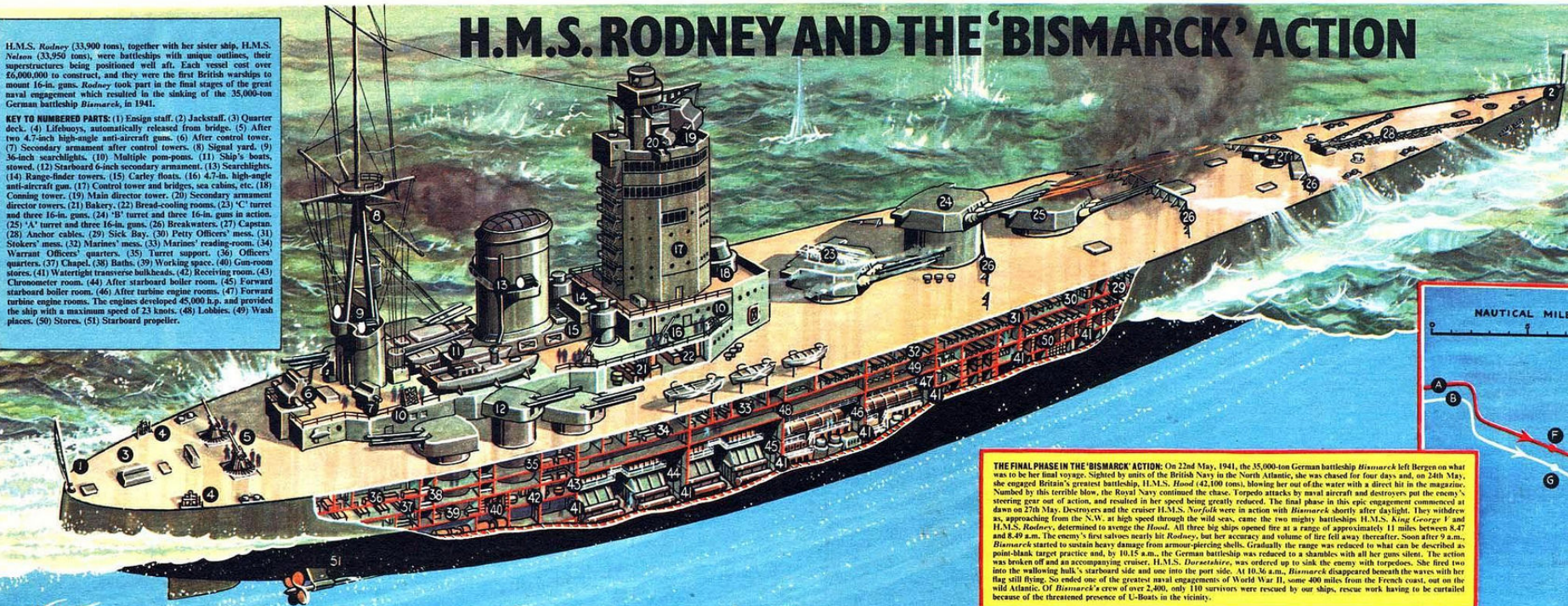
(1) Section of snow to be cleared. (2) Nose of plough digs into the snow. (3) These blades are cutting. (4) Revolving conical scoops which collect the snow and discharge it by centrifugal force through the top of the casing. (5) These blades are hinged back, and are used for reverse action. (6) Direction of cutting wheel. (7) Snow exit. (8) Reversible hood. (9) Searchlight. (10) Bearings for main shaft. (11) Piston and connecting rod of forward cylinder of vertical marine type steam engine. (12) Flywheel. (13) Link motion for steam valves. (14) Reversing levers on each side of engine. (15) Steam regulator on each side of engine. (16) Steam pipe from boiler. (17) Exhaust steam to blast pipe. (18) Connecting rod of rear cylinder. (19) Scoop clearing loose snow from track. (20) Pumps and lighting dynamo. (21) Exhaust blast pipe. (22) Chimney bell. (23) Fire tubes of boiler. (24) Steam collecting dome and regulator valve. (25) Firebox. (26) Coal supply. (27) Water supply. (28) Locomotives pushing the plough against the snow.



# H.M.S. RODNEY AND THE 'BISMARCK' ACTION

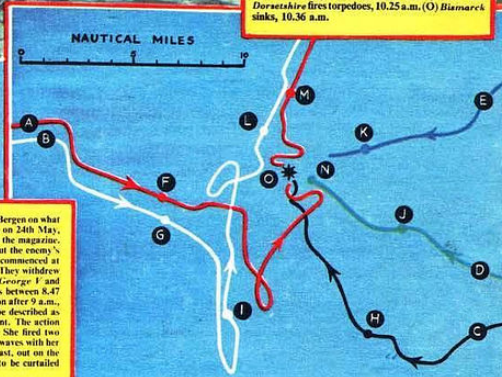
H.M.S. *Rodney* (33,900 tons), together with her sister ship, H.M.S. *Nelson* (33,950 tons), were battleships with unique outlines, their superstructures being positioned well aft. Each vessel cost over £6,000,000 to construct, and they were the first British warships to mount 16-in. guns. *Rodney* took part in the final stages of the great naval engagement which resulted in the sinking of the 35,000-ton German battleship *Bismarck*, in 1941.

**KEY TO NUMBERED PARTS:** (1) Ensign staff. (2) Jackstaff. (3) Quarter deck. (4) Lifebuoys, automatically released from bridge. (5) After two 4.7-inch high-angle anti-aircraft guns. (6) After control tower. (7) Secondary armament after control towers. (8) Signal yard. (9) 36-inch searchlights. (10) Multiple pom-poms. (11) Ship's boats, stowed. (12) Starboard 6-inch secondary armament. (13) Searchlights. (14) Range-finder towers. (15) Carley floats. (16) 4.7-in. high-angle anti-aircraft gun. (17) Control tower and bridges, sea cabins, etc. (18) Conning tower. (19) Main director tower. (20) Secondary armament director towers. (21) Bakery. (22) Bread-cooling rooms. (23) 'C' turret and three 16-in. guns. (24) 'B' turret and three 16-in. guns in action. (25) 'A' turret and three 16-in. guns. (26) Breakwater. (27) Capstan. (28) Anchor cables. (29) Sick Bay. (30) Petty Officers' mess. (31) Stokers' mess. (32) Marines' mess. (33) Marines' reading-room. (34) Warrant Officers' quarters. (35) Turret support. (36) Officers' quarters. (37) Chapel. (38) Baths. (39) Working space. (40) Gun-room stores. (41) Watertight transverse bulkheads. (42) Receiving room. (43) Chronometer room. (44) After starboard boiler room. (45) Forward starboard boiler room. (46) After turbine engine rooms. (47) Forward turbine engine rooms. The engines developed 45,000 h.p. and provided the ship with a maximum speed of 23 knots. (48) Lobbies. (49) Wash places. (50) Stores. (51) Starboard propeller.



## KEY TO FINAL PHASE OF ACTION

(A) Course of H.M.S. *Rodney*. (B) Course of H.M.S. *King George V*. (C) Course of *Bismarck*. (D) Approximate course of H.M.S. *Dorsetshire*. (E) Approximate course of H.M.S. *Norfolk*. (F) *Rodney* opens fire, 8.47 a.m. (G) *King George V* opens fire, 8.48 a.m. (H) *Bismarck* opens fire, 8.49 a.m. (I) Position, 9.20 a.m. (J) Position, 10.0 a.m. (K) Position, 10.0 a.m. (L) Cease fire, 10.22 a.m. (M) Position, 10.23 a.m. (N) H.M.S. *Dorsetshire* fires torpedoes, 10.25 a.m. (O) *Bismarck* sinks, 10.36 a.m.



**THE FINAL PHASE IN THE 'BISMARCK' ACTION:** On 22nd May, 1941, the 35,000-ton German battleship *Bismarck* left Bergen on what was to be her final voyage. Nighted by units of the British Navy in the North Atlantic, she was chased for four days and, on 24th May, she engaged Britain's greatest battleship, H.M.S. *Hood* (42,100 tons), blowing her out of the water with a direct hit in the magazine. Numbered by this terrible blow, the Royal Navy continued the chase. Torpedo attacks by naval aircraft and destroyers put the enemy's steering gear out of action, and resulted in her speed being greatly reduced. The final phase in this epic engagement commenced at dawn on 27th May. Destroyers and the cruiser H.M.S. *Norfolk* were in action with *Bismarck* shortly after daylight. They withdrew as, approaching from the N.W. at high speed through the wild seas, came the two mighty battleships H.M.S. *King George V* and H.M.S. *Rodney*, determined to avenge the *Hood*. All three big ships opened fire at a range of approximately 11 miles between 8.47 and 8.49 a.m. The enemy's first salvos nearly hit *Rodney*, but her accuracy and volume of fire fell away thereafter. Soon after 9 a.m., *Bismarck* started to sustain heavy damage from armour-piercing shells. Gradually the range was reduced to what can be described as point-blank target practice and, by 10.15 a.m., the German battleship was reduced to a shambles with all her guns silent. The action was broken off and an accompanying cruiser, H.M.S. *Dorsetshire*, was ordered up to sink the enemy with torpedoes. She fired two into the wallowing hull's starboard side and one into the port side. At 10.36 a.m. *Bismarck* disappeared beneath the waves with her flag still flying. So ended one of the greatest naval engagements of World War II, some 400 miles from the French coast, out on the wild Atlantic. Of *Bismarck's* crew of over 2,400, only 110 survivors were rescued by our ships, rescue work having to be curtailed because of the threatened presence of U-Boats in the vicinity.



# HMS WARSPITE

Launched in 1913, this famous veteran battleship was affectionately called the 'Old Lady' by the British Navy. She took part in the Battle of Jutland during the First World War, and in many other renowned engagements during World War II. One of the most memorable being the historic action on 13th April, 1940, at Narvik. With a force of 'Tribal' Class destroyers, she proceeded up Ofot Fjord and trapped seven large enemy destroyers, all of which were wiped out in the ensuing action by the British ships. In October, 1945, it was announced that the grand old warrior - then over 30 years old - was to be retired from active service. In 1947, she was sold for breaking-up and, whilst being taken from Portsmouth to the ship-breaker's yard on the Clyde, she was driven on the rocks during a gale at Prussia Cove in Cornwall, on 13th April of that year. It was therefore decided to break her up where she lay. During her long career, H.M.S. Warspite underwent many alterations. Our drawing shows her as she appeared before the commencement of World War II.

## KEY TO NUMBERED PARTS:

(1) Stern walk. (2) One of the twin rudders. (3) Starboard propellers. (4) Quarter deck. (5) Admiral's day cabin. (6) Admiral's dining cabin. (7) Admiral's sleeping cabin. (8) Admiral's bath. (9) Admiral's spare cabin. (10) Officers' cabins. (11) Stores. (12) Captain of the Fleet's day and dining cabin. (13) Fresh water tanks. (14) Sleeping cabin. (15) Fleet Captain's bath. (16) Awning stowage. (17) Bath. (18) Wardroom stores. (19) Church. (20) Senior Officers' wash. (21) Stores. (22) Spirit room. (23) Bathrooms. (24) Turbo-generators and hydraulic machinery. (25) Artificers' fitting shop. (26) Main wireless cabin. (27) Captain's day cabin. (28) Captain's sleeping cabin. (29) Commander's cabin. (30) Chaplain's cabin. (31) Pantries. (32) Officers' servants' Stewards' and Cooks' mess. (33) Catapult passage. (34) Walrus amphibian aircraft on adwardship catapult. (35) Sergeants' of Marines mess. (36) Main machinery workshops. (37) Starboard engine room. (38) Geared turbines. The engines developed 80,000 h.p. and gave the ship a speed of 24 knots. (39) No. 5 boiler room. (40) No. 3 boiler room. (41) No. 1 boiler room. (42) Entrance locks. (43) Fuel tanks. (44) Mess spaces. (45) Gun room. (46) Warrant Officers' mess. (47) Engineers' fitting shop. (48) Wash spaces. (49) Hammock stowages. (50) Fuel tanks. (51) Central store. (52) Medical distributing station. (53) Anti-torpedo bulge. (54) Lower wireless cabin. (55) Chief Stokers' and Mechanics' mess. (56) Petty Officers. (57) Lobby. (58) Seamen's heads. (59) Boatwains' store. (60) Chief Petty Officers' mess. (61) Canvas and cordage store. (62) Spare cables. (63) Shipwrights' workshops. (64) Sick-bay. (65) Operating theatre. (66) Clothing issue. (67) Reading-room. (68) Cloak-room. (69) Flour store. (70) Cold storage chambers. (71) Ram bow. (72) Starboard battery of four 6 inch guns. (73) Anchor cables. (74) Breakwater. (75) 'A' Turret. Two 15 inch guns. (76) 'B' Turret. Two 15 inch guns. (77) 'X' Turret. Two 15 inch guns. (78) 'Y' Turret. Two 15 inch guns. (79) Multiple machine-guns. (80) Multiple pom-pom anti-aircraft guns. (81) Starboard forward twin 4 inch anti-aircraft guns. (82) Starboard aft twin 4 inch anti-aircraft guns. (83) Ship's galleys. (84) Gyro adjusting room. (85) Electric light store. (86) Conning tower. (87) Searchlights. (88) Admiral's sea cabin. (89) Watch Officer's cabin. (90) Petty Officers' reading-room. (91) General reading-room. (92) Main director tower. (93) Pole foremast. (94) Director towers. (95) Admiral's barge. (96) 42 ft. sailing launch. (97) Two 45 ft. motor speed-boats. (98) Aircraft crane. (99) 32 ft. cutter. (100) Cutters. (101) Carley float. (102) After director tower. (103) Mainmast.



# THE ARMY'S FERRET

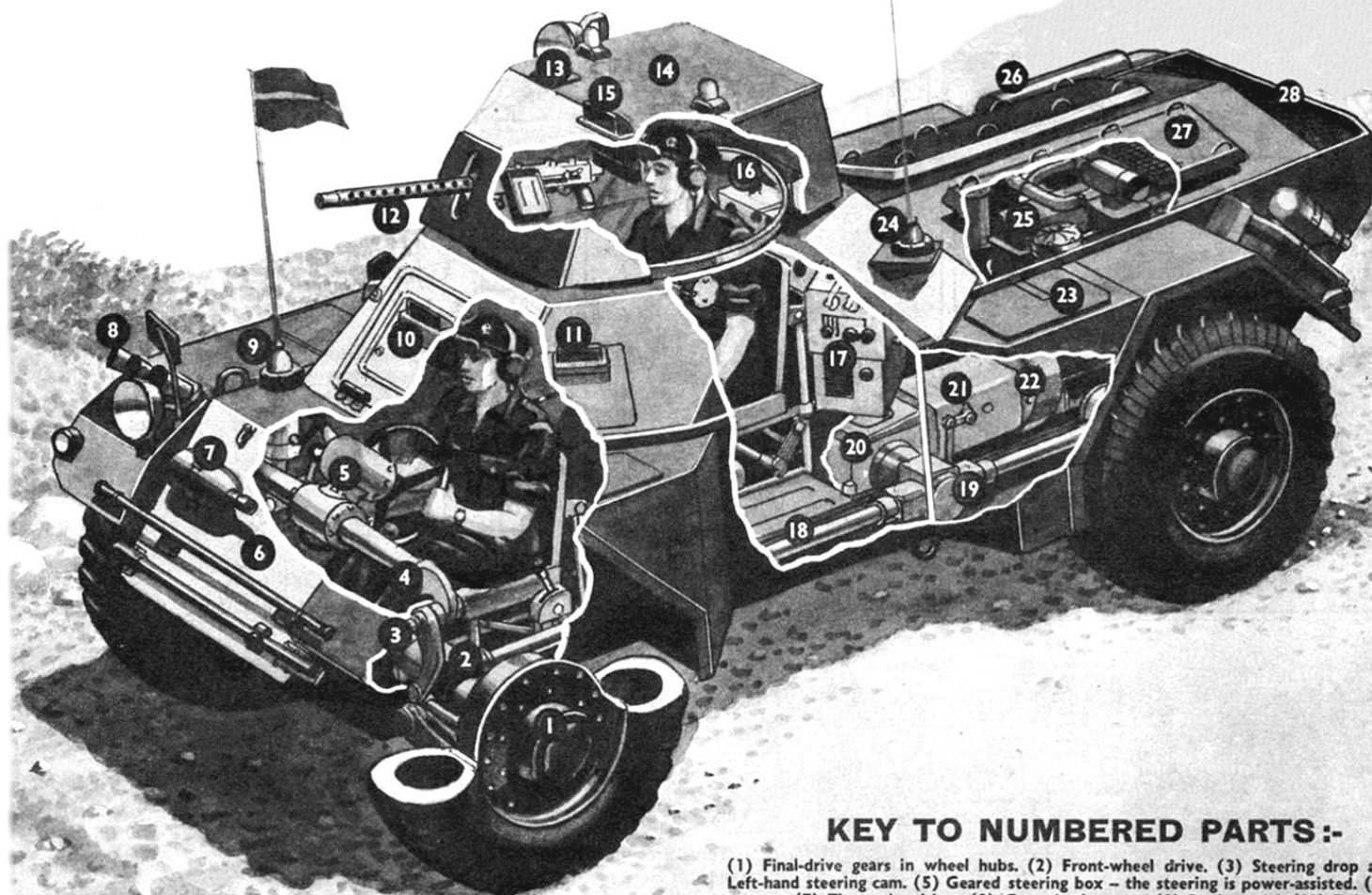


In service with the British Army all over the world, the Ferret Mark 2 is the standard scout car and liaison vehicle of both the Infantry and Royal Armoured Corps. They have taken part in British campaigns in Malaya, the Middle East, Kenya and Cyprus.

The Ferret is an outstandingly successful car, powered by a Rolls-Royce B.60 petrol engine of 96 h.p. It has four-wheel drive with five forward - and five reverse-gear speeds. Top road speed - 58 m.p.h., range

- 189 miles. The battle weight is 4 tons, 6½ cwt. A crew of two is carried - commander/turret operator and a driver. Armament: one .30-in. Browning machine-gun.

The performance over rough ground is outstanding, with the ability to climb gradients up to 1 in 2. The engine will operate fully submerged, so that the vehicle can wade in water up to 4 feet deep. Fine vehicles like this, and others, make a career in the modern Army most attractive.



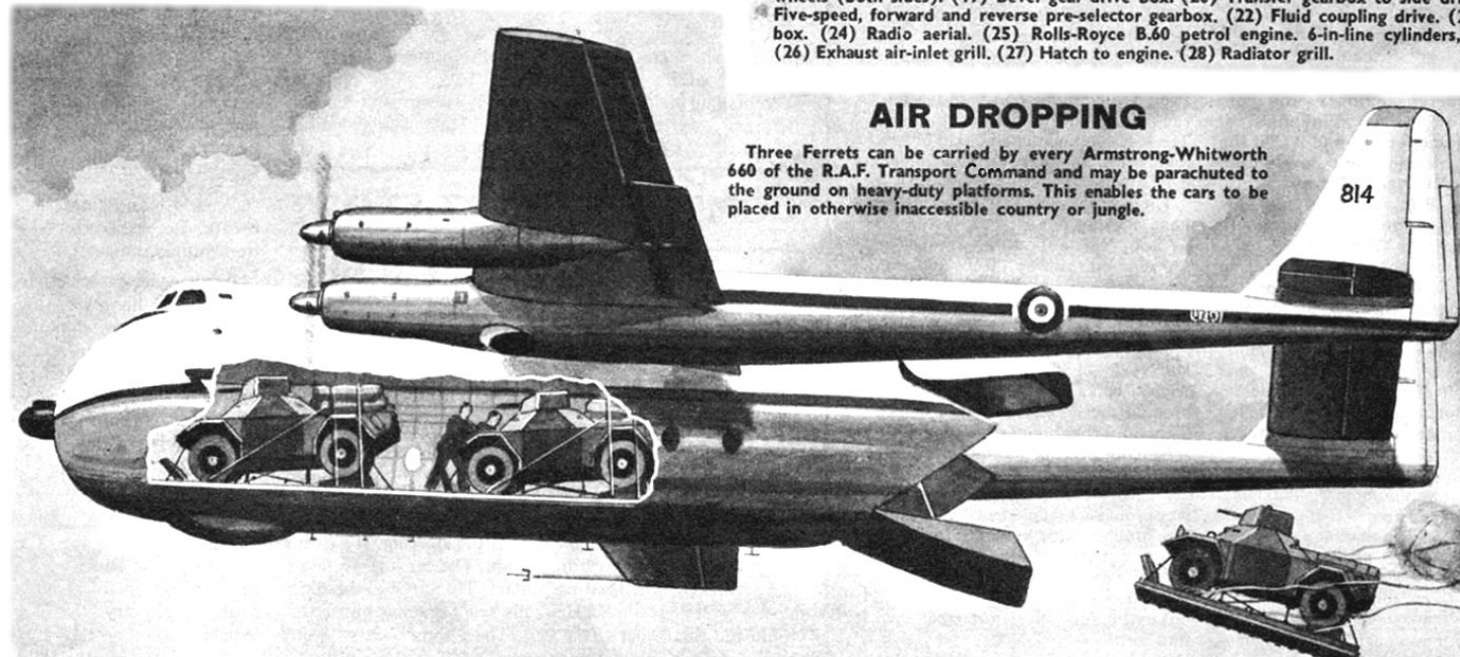
ASHWELL  
WOOD

## KEY TO NUMBERED PARTS:-

- (1) Final-drive gears in wheel hubs. (2) Front-wheel drive. (3) Steering drop arm. (4) Left-hand steering cam. (5) Geared steering box - the steering is power-assisted. (6) Front armour. (7) The extinguisher. (8) Grenade throwers. (9) Radio aerial. (10) Driver's periscope and entrance hatch. (11) Driver's side periscope. (12) Browning .30-in. machine-gun. (13) Searchlight. (14) Commander's opening hatch. (15) Commander's periscope. (16) Hand-operated, revolving turret ring. (17) V.H.F. radio equipment. (18) Drive-shaft to front wheels (both sides). (19) Bevel gear drive box. (20) Transfer gearbox to side drive. (21) Five-speed, forward and reverse pre-selector gearbox. (22) Fluid coupling drive. (23) Tool box. (24) Radio aerial. (25) Rolls-Royce B.60 petrol engine. 6-in-line cylinders, 96 h.p. (26) Exhaust air-inlet grill. (27) Hatch to engine. (28) Radiator grill.

## AIR DROPPING

Three Ferrets can be carried by every Armstrong-Whitworth 660 of the R.A.F. Transport Command and may be parachuted to the ground on heavy-duty platforms. This enables the cars to be placed in otherwise inaccessible country or jungle.





# HANDLEY PAGE VICTOR B1

The Handley Page Victor bomber is the latest, and probably the last, in a long line of aircraft in service with the R.A.F. since its earliest days. Powered by four Bristol Siddeley Sapphire jet engines, the Victor has a long range which is further increased by in-flight refuelling (long-range fuel tanks can also be fitted). At high altitude, this V-bomber cruises at speeds in the region of Mach 0.9, which forces intercepting fighters to manoeuvre at transonic speed at a disadvantage.

The Victor can carry either free-falling kiloton or megaton nuclear weapons, or the Blue Steel inertial-guided stand-off bomb with a megaton warhead. The crew consists of: captain, co-pilot, navigator/plotter, navigator/radar operator and air electronics officer.

## Key to numbered parts

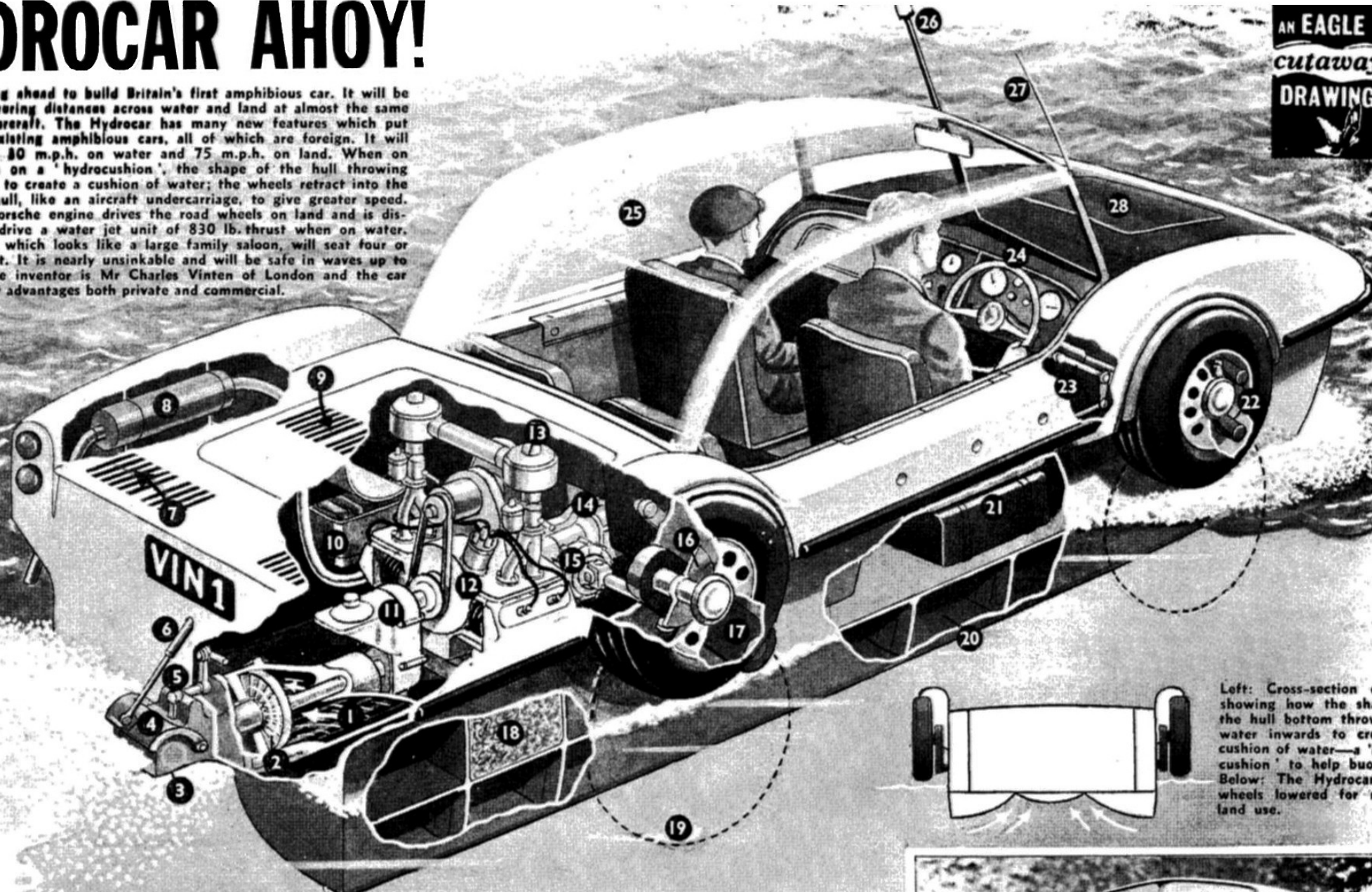
(1) Bomb-aimer's window. (2) Nose radome. (3) Refuelling probe. (4) Crew compartment. (5) Twin nose-wheels. (6) Air intakes. (7) Bag-type fuel tanks. (8) Starboard aileron. (9) Flaps. (10) Inner-wing main spars. (11) Four Bristol Armstrong Siddeley Sapphire jet engines. (12) Bogie-type main undercarriage. (13) Flap guide housings. (14) Outer-wing main spars. (15) Leading-edge flaps. (16) Port wing vortex generators. (17) Port aileron and trim tab. (18) Pitot tube. (19) Port navigation light. (20) Large bomb-bay. (21) Reinforced bulkheads. (22) Intake trunk. (23) Rear access door. (24) Air brake. (25) Tail radome. (26) Rudder. (27) Bullet faring. (28) Hot air de-icing trunk. (29) Elevator. (30) Hot air outlet.



# HYDROCAR AHoy!

Plans are going ahead to build Britain's first amphibious car. It will be capable of covering distances across water and land at almost the same speed as Hovercraft. The Hydrocar has many new features which put it ahead of existing amphibious cars, all of which are foreign. It will be capable of 30 m.p.h. on water and 75 m.p.h. on land. When on water it rides on a 'hydrocushion', the shape of the hull throwing water inwards to create a cushion of water; the wheels retract into the sides of the hull, like an aircraft undercarriage, to give greater speed. A 107 h.p. Porsche engine drives the road wheels on land and is disconnected to drive a water jet unit of 830 lb. thrust when on water. The hydrocar, which looks like a large family saloon, will seat four or five in comfort. It is nearly unsinkable and will be safe in waves up to 4 ft. high. The inventor is Mr Charles Vinten of London and the car will have many advantages both private and commercial.

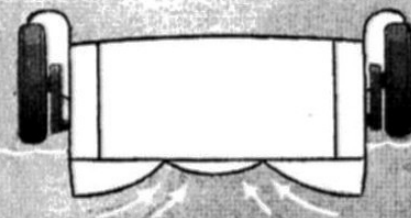
AN EAGLE  
cutaway  
DRAWING



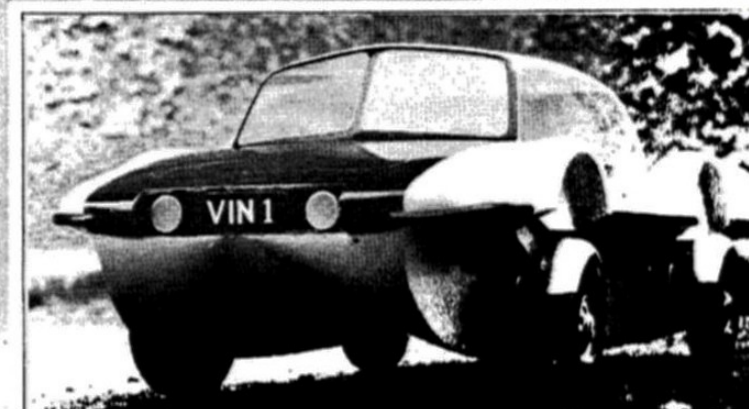
## KEY TO HOW IT WORKS

(1) Water inlet to jet unit. (2) Turbine wheel creating forward thrust. (3) Water jet nozzle. (4) Reversing plate—this drops over the nozzle and directs the water jet in the opposite direction for reverse. (5) Steering arm controls two 'deflection plates' for steering. (6) Reverser control jack. (7) Engine cooling air outlet. (8) Exhaust silencer—both sides. (9) Engine cooling air inlet. (10) Battery. (11) Gear drive to water jet unit. (12) 107 h.p. Porsche flat 4-cylinder, air-cooled engine. (13) Carburettor air filters. (14) Four-speed road gearbox. (15) Drive to road wheels — disconnected when on water.

(16) Disc brakes. (17) Chain drive from engine to road wheels, which are here shown retracted upwards. (18) Buoyancy spaces filled with polythene foam. (19) Position of road wheels when lowered by suspension arms. (20) Hull bottom shaped to create a cushion of water. (21) Fuel tank. (22) Front wheel suspension arms raised. (23) Steering connection to water jet unit. (24) Steering wheel can alternately be used for road wheels when on land. (25) Rear-hinged plastic canopy. (26) Navigation light. (27) Radio aerial. (28) Forward boot for spare wheel and luggage.



Left: Cross-section of car showing how the shape of the hull bottom throws the water inwards to create a cushion of water—a 'hydrocushion' to help buoyancy. Below: The Hydrocar with wheels lowered for normal land use.





# The New Look AND Learn

With World Of Knowledge

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## The Space-Age Sailing Ship

IS THE SUBJECT THIS WEEK  
ON HARDY'S DRAWING BOARD



SATELLITE NAVIGATOR

LON 14 22.54

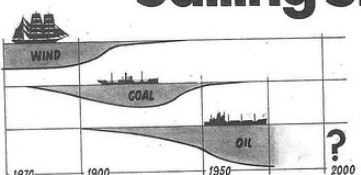


## HARDY'S DRAWING BOARD

One of Britain's top technical illustrators presents a weekly look at the world of science and technology...

## The Space-Age Sailing Ship

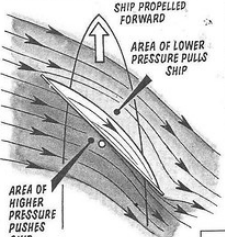
The energy crisis has given an intrepid design team the opportunity to show there is still a place for wind power at sea — in the shape of a 'sailiner'.



A HUNDRED YEARS AGO THE WORLD'S MERCHANT FLEETS CONSISTED ALMOST ENTIRELY OF SAILING SHIPS. OVER THE NEXT FORTY YEARS CHEAP COAL TO POWER STEAM ENGINES TOOK OVER ALMOST ENTIRELY. AS THE FUTURE OF OIL BECOMES FOR STEAM BOILERS, THEN AS DIESEL ENGINE FUEL.

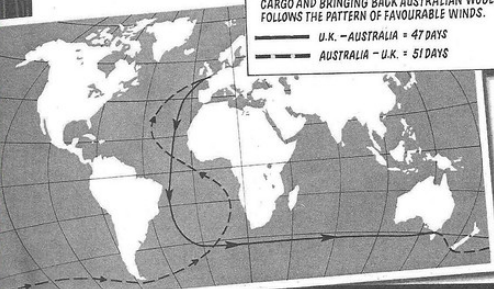
LIMITED, SOME DESIGNERS ARE TURNING AGAIN TO WIND POWER. CAPTAIN MIKE WILLOUGHBY AND WINDROSE SHIPS LTD. HAVE DESIGNED A SHIP TO USE THE WELL-TRIED TECHNIQUES OF SAILING COMBINED WITH MODERN MATERIALS AND EQUIPMENT.

THE CURVE OF A SAIL IS SIMILAR IN SHAPE TO AN AIRCRAFT'S WING AND BEHAVES IN THE SAME WAY. IN THE DIAGRAM (LEFT) THE SHIP IS RUNNING "CLOSE-HAULED" ACROSS THE WIND. THE AIRFLOW ACROSS THE FACE OF THE SAIL HAS TO MOVE FASTER OVER THE CURVE THAN THE AIR PASSING BEHIND IT. THIS CREATES THE PRESSURE DIFFERENCE SHOWN WHICH SUCKS THE SAIL, AND THE SHIP, FORWARD.

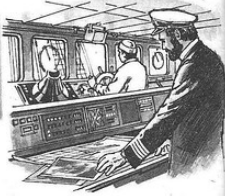


THE SAILINER'S ROUTE, TAKING OUT GENERAL CARGO AND BRINGING BACK AUSTRALIAN WOOD, FOLLOWS THE PATTERN OF FAVOURABLE WINDS.

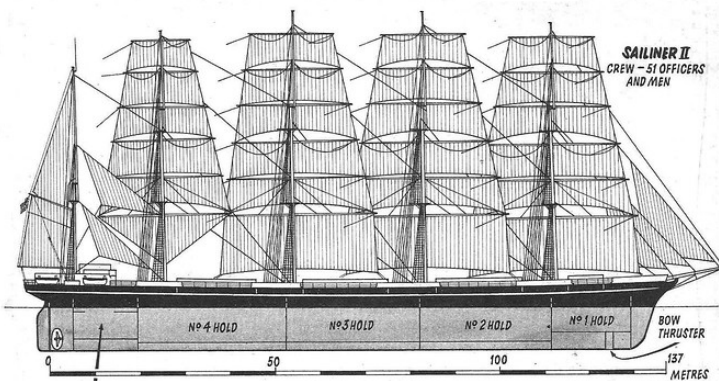
U.K. - AUSTRALIA = 47 DAYS  
AUSTRALIA - U.K. = 51 DAYS



THE DESIGNERS LOOKED AT THE HIGH AVERAGE SPEEDS REPORTED BY CLIPPERS ON THE AUSTRALIA RUN AND THE LOGS OF BRUNEL'S "GREAT BRITAIN" WHICH, USING SAIL AND STEAM, MADE 27 ROUND TRIPS TO AUSTRALIA AT AN AVERAGE SPEED OF 9-35 KNOTS (16-89 KPH).

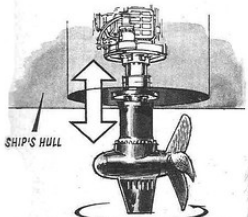


THE SAILINER'S MASTER WILL HAVE AT HIS DISPOSAL ALL THE MODERN ELECTRONICS THE OLD CLIPPER CAPTAINS DID NOT HAVE. RADIO, RADAR, CONTINUOUS PINPOINT POSITION READ-OUTS AND WEATHER PICTURES FROM SATELLITES. MOST SHIPS' MASTERS NEED A ROUTE AVOIDING WINDS. THE SAILINER'S MASTER WILL BE USING HIS SKILL TO FIND THE WINDS TO SPEED HIM ALONG!

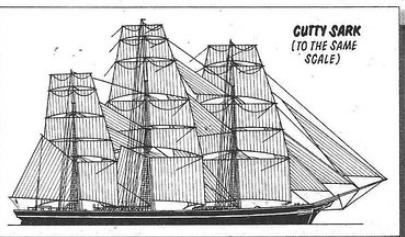


### ENGINE AND MACHINERY SPACE

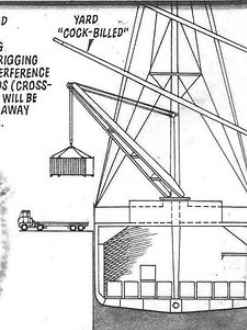
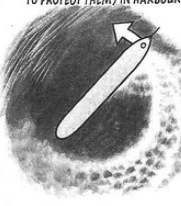
SAILINER II IS A GIANT SAILING SHIP WITH A CARGO CAPACITY OF 15,500 TONNES. THE SQUARE-RIGGED SAIL PLAN IS TRADITIONAL AND WELL-TRIED. HER DIESEL ENGINE WILL BE USED WHEN NEEDED TO MAINTAIN HER AVERAGE SPEED OF 12 KNOTS (21-72 KPH). HER CONSTRUCTION WILL USE THE MOST MODERN STEELS AND LIGHT ALLOYS. HER ENGINE PROPELLOR, PUMPS, REFRIGERATION, CRANES AND CARGO HATCH COVERS ARE ALSO UP-TO-DATE. SHE WILL SPEND MOST OF HER TIME "HEELED OVER" BY THE WIND - SO ALL HER EQUIPMENT MUST BE DESIGNED ACCORDINGLY.



THE OLD CLIPPERS RELIED ON STEAM TUGS TO MANOEUVRE THEM IN THE CONFINES OF HARBOURS. SAILINER II WILL BE FITTED WITH A BOW THRUSTER PROPELLOR TO ALLOW HER TO DOCK INDEPENDENTLY, TURNING IN HER OWN LENGTH IF NECESSARY. WHEN NOT IN USE THE THRUSTER RETRACTS NEATLY INTO THE HULL (SEE SIDE VIEW OF SHIP).



SAILINER II WILL LOAD AND UNLOAD HERSELF. THE CRANES WILL BE OPERATED BY STEVEPORES USING PORTABLE CONTROL BOXES. THE RIGGING HAS BEEN DESIGNED TO AVOID INTERFERENCE WITH THE CRANES, AND THE YARDS (CROSS-BEAMS THAT CARRY THE SAILS) WILL BE "COCK-BILLED" (ANGLED UP AND AWAY TO PROTECT THEM) IN HARBOUR.

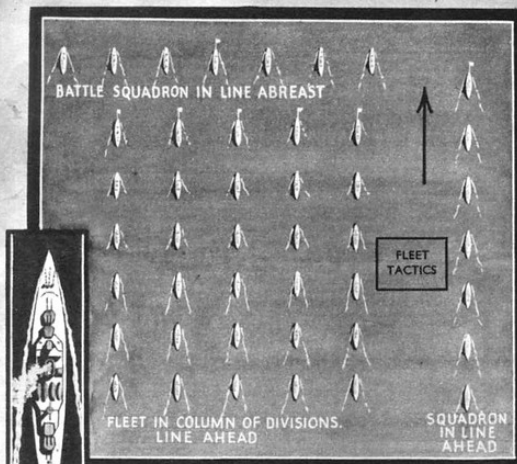


MANY THANKS TO CAPTAIN MIKE WILLOUGHBY FOR MUCH HELP WITH THIS FEATURE.

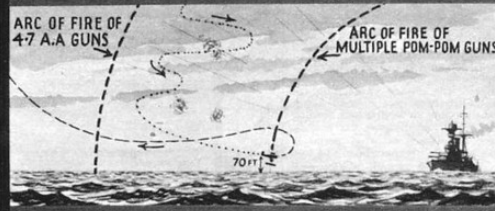


# THE NAVY IN ACTION

THIS is Navy Week, and many readers will be going "behind the scenes" of the Senior Service. On these pages are illustrated some of the modern wonders of the Royal Navy. If you are fortunate enough to go over one of the new battleships, a study of the one pictured below will make your visit much more interesting.



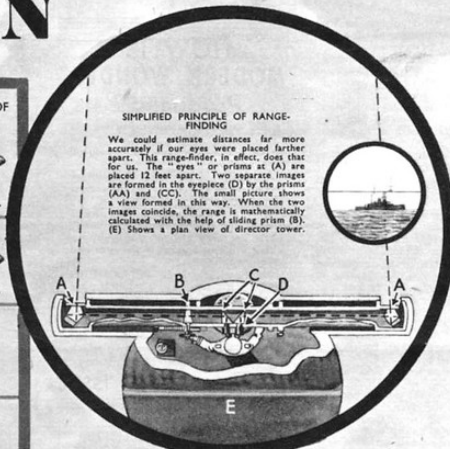
Actual size of a battleship as seen from a bombing aeroplane at 6,000 feet.



## AEROPLANE v. BATTLESHIP

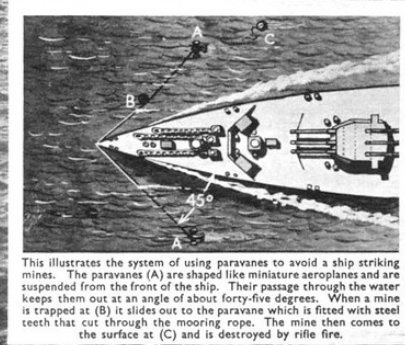
Before a torpedo-carrying aircraft can discharge its torpedoes at a battleship it must come down to within 70-100 feet of the sea. If it were to drop them from a greater height contact with the sea would cause them to explode. The above drawing gives an idea of the arc of fire to which aircraft are subjected from a modern battleship.

| PRINCIPAL GUNS USED IN THE NAVY TODAY | WEIGHT OF SHELL |
|---------------------------------------|-----------------|
| 16-inch                               | 2,461 lbs.      |
| 15-inch                               | 1,920 lbs.      |
| 8-inch                                | 256 lbs.        |
| 6-inch                                | 100 lbs.        |
| 4.7 A.A.                              | 50 lbs.         |
| Multiple pom-pom                      | 2 lbs.          |



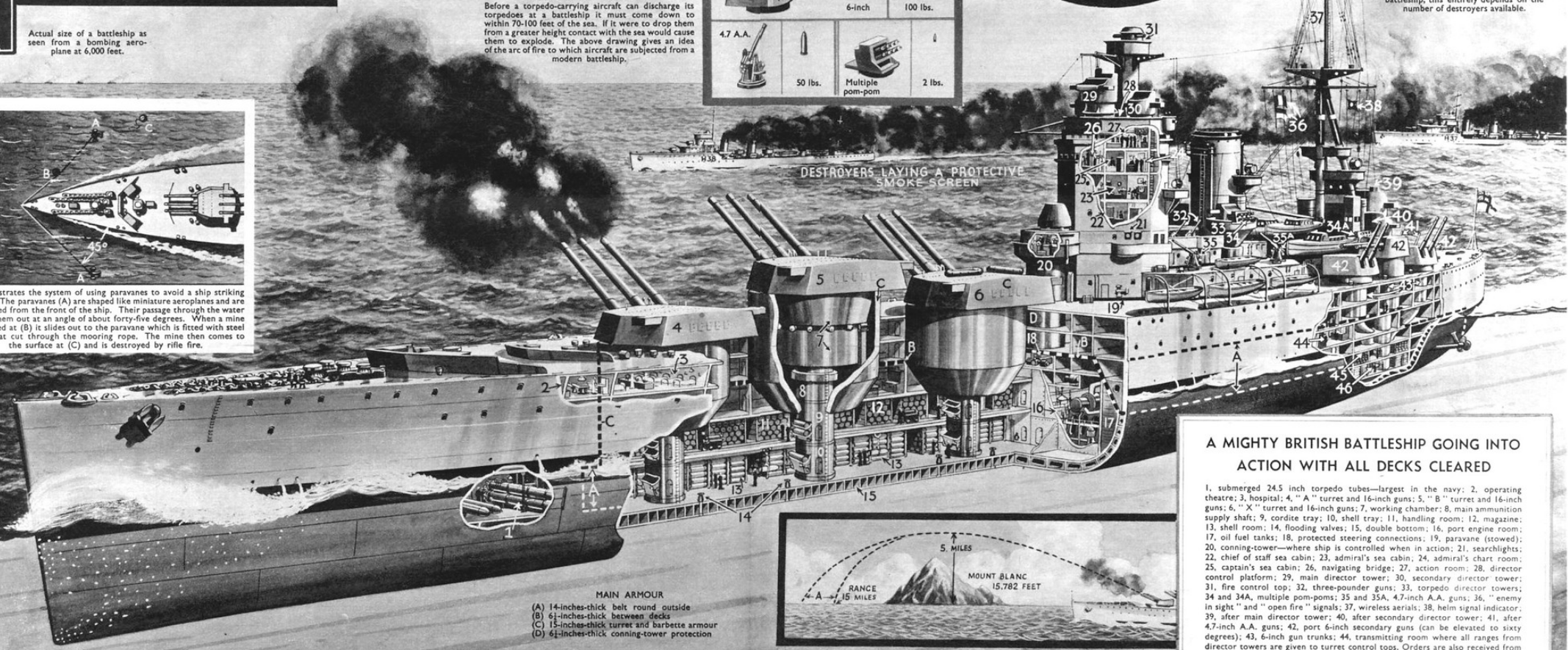
New type Fairey "Sea-Fox" spotting seaplane: 400 H.D. Rapier VI engine used for fleet co-operation.

The destroyers accompanying the battleship are laying a protective smoke screen. There is no specific number of these smaller craft forming an escort to the battleship, this entirely depends on the number of destroyers available.

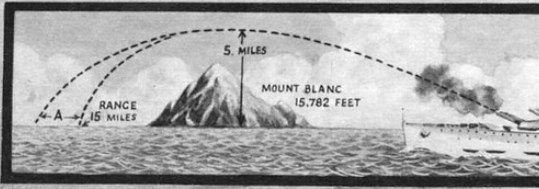


This illustrates the system of using paravanes to avoid a ship striking mines. The paravanes (A) are shaped like miniature aeroplanes and are suspended from the front of the ship. Their passage through the water keeps them out at an angle of about forty-five degrees. When a mine is trapped at (B) it slides out to the paravane which is fitted with steel teeth that cut through the mooring rope. The mine then comes to the surface at (C) and is destroyed by rifle fire.

## DESTROYERS LAYING A PROTECTIVE SMOKE SCREEN



- MAIN ARMOUR
- (A) 14-inches-thick belt round outside
  - (B) 61-inches-thick between decks
  - (C) 15-inches-thick turret and barbette armour
  - (D) 61-inches-thick conning-tower protection



## THE RANGE AND TRAJECTORY OF A MODERN 16-INCH NAVAL GUN AND SHELL

(A) represents the effect of air resistance. The shell has a muzzle velocity of 1,800 miles an hour, and a rate of fire of one round a minute.

## A MIGHTY BRITISH BATTLESHIP GOING INTO ACTION WITH ALL DECKS CLEARED

- 1, submerged 24.5 inch torpedo tubes—largest in the navy; 2, operating theatre; 3, hospital; 4, "A" turret and 16-inch guns; 5, "B" turret and 16-inch guns; 6, "X" turret and 16-inch guns; 7, working chamber; 8, main ammunition supply shaft; 9, cordite tray; 10, shell tray; 11, handling room; 12, magazine; 13, shell room; 14, flooding valves; 15, double bottom; 16, port engine room; 17, oil fuel tanks; 18, protected steering connections; 19, paravane (stowed); 20, conning-tower—where ship is controlled when in action; 21, searchlights; 22, chief of staff sea cabin; 23, admiral's sea cabin; 24, admiral's chart room; 25, captain's sea cabin; 26, navigating bridge; 27, action room; 28, director control platform; 29, main director tower; 30, secondary director tower; 31, fire control top; 32, three-pounder guns; 33, torpedo director towers; 34 and 34A, multiple pom-poms; 35 and 35A, 4.7-inch A.A. guns; 36, "enemy in sight" and "open fire" signals; 37, wireless aerials; 38, helm signal indicator; 39, after main director tower; 40, after secondary director tower; 41, after 4.7-inch A.A. guns; 42, port 6-inch secondary guns (can be elevated to sixty degrees); 43, 6-inch gun trunks; 44, transmitting room where all ranges from director towers are given to turret control tops. Orders are also received from captain and fire directors and transmitted to their proper places; 45, 6-inch gun magazines and handling rooms; 46, 6-inch shell room.

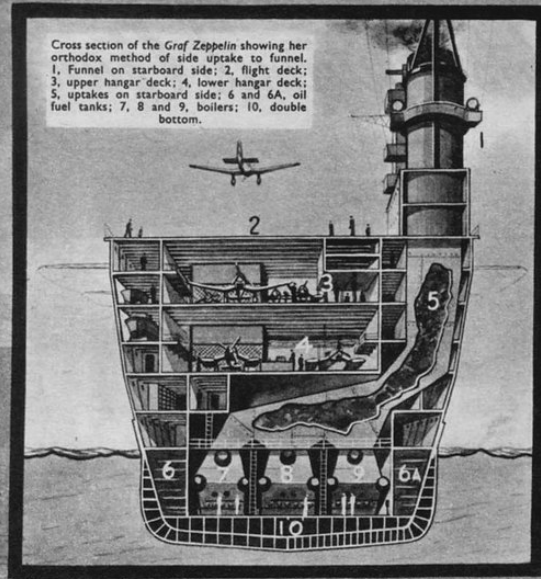


# NEW NAZI HORNETS' NEST

## THE GERMAN AIRCRAFT CARRIER "GRAF ZEPPELIN"

THE first aircraft carrier ever built for the Nazi Navy was launched at Kiel some fifteen months ago, and according to information received is now completed. A second vessel is being built at Kiel. Although it was expected that this ship would be of revolutionary design, the *Graf Zeppelin* is similar to our own ships and is not so large as the *Ark Royal*. She will accommodate only forty aircraft against the *Ark Royal*'s sixty. The German experts had visions of the *Graf Zeppelin* operating in the Atlantic, using her dive bombers against our shipping, but she will never dare run the gauntlet of the British Navy's

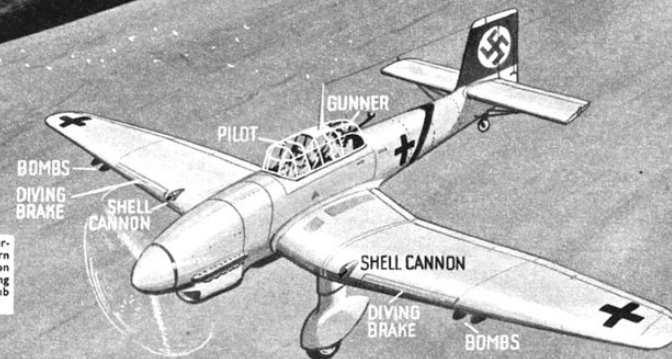
ceaseless vigilance in the North Sea, and is more likely to remain in the landlocked waters of the Baltic where we show her exercising with the latest type Junkers dive bombers with which she will be equipped. She is a vessel of 19,250 tons with a speed of thirty-two knots, and carries sixteen 5.9-in. guns, ten 4.1-in. anti-aircraft guns and twenty-two smaller ones. How she will fare in a big sea with this heavy armament remains to be seen. This is the first detailed drawing to be published of her and is exclusive to *Modern World*.



### KEY TO PARTS

- 1, New type bulbous bow or wave resister; 2, narrow cut-water; 3, rounded bows with bollard; 4, port anchors; 5-5A, 4.1-in. anti-aircraft guns; 6, steam jet for wind direction; 7-7A, impellers or catapults; 8, flight deck, 790 ft. long by 88 ft. wide; 9-9A, multiple machine guns; 10, forward aircraft lift; 11, forward 5.9-in. guns; 12, superstructure; 13, conning tower; 14, rangefinder; 15, sea cabins and navigating bridge; 16, fire control top; 17, 4.1-in. anti-aircraft guns; 18, amidships aircraft lift; 19, after 5.9-in. guns; 20, overhanging stern; 21, wireless mast; 22, port propeller and rudder; 23, port 5.9-in. gun turret; 24, boats stowed; 25, fans; 26, boat deck; 27, auxiliary diesel engines; 28, port engine room and turbines; 29, after boiler room; 30, air lock; 31, wing store; 32, lower hangar deck; 33, upper hangar deck; 34, stokers' wash place; 35, auxiliary machinery; 36, forward boiler room; 37, oil fuel tanks; 38, dynamos; 39, petrol tanks; 40, aero-engine shop; 41, aircraft lifts; 42, port 5.9-in. gun turrets; 43, machine shop; 44, seamen's mess; 45, seamen's mess; 46, ammunition trunk; 47, sick bay; 48, main armour belt.

The latest type of Junkers "JU. 87," the German dive bombing equivalent of our Blackburn "Skua." An unusual feature is the installation of "diving brakes" fitted in the leading edges of the wings. A large 500 k.g. bomb is also carried beneath the fuselage.





# TRANSATLANTIC LINER of the FUTURE

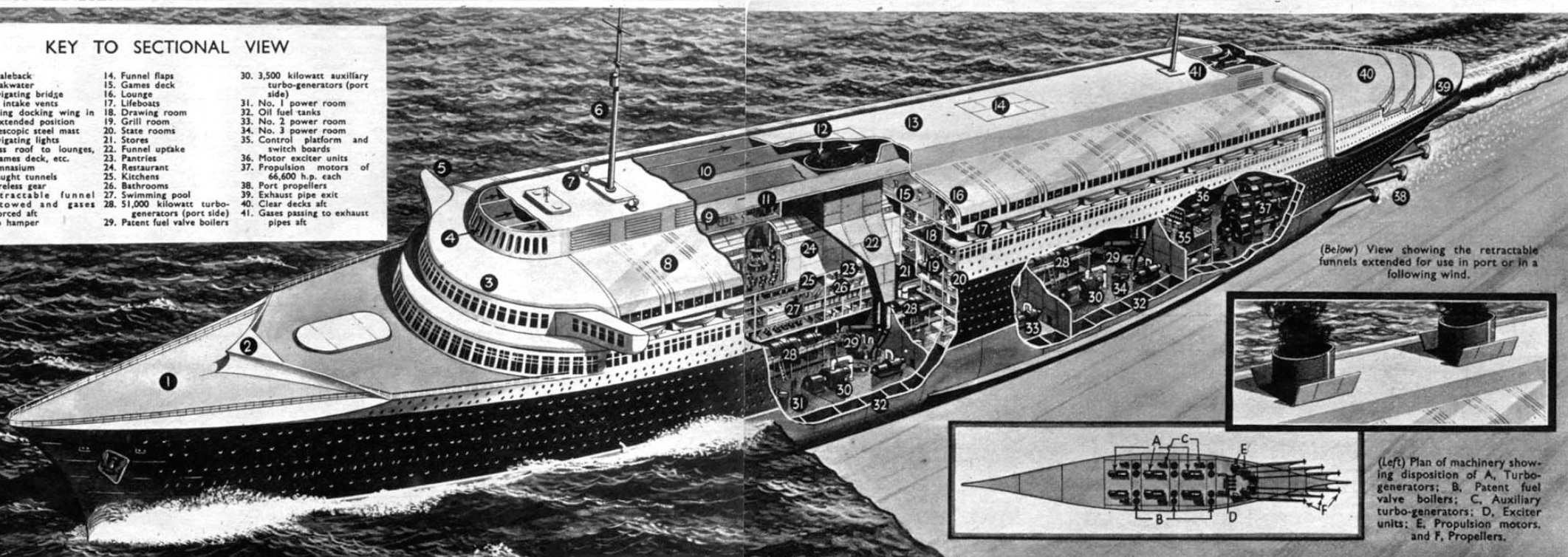
## STREAMLINED THROUGHOUT

**T**HE big ocean-going liner as we know it today, is passing. Probably never again—after the present building programmes are finished—shall we see a liner like the *Queen Mary* or the *Normandie* sliding down the slipway to the sea.

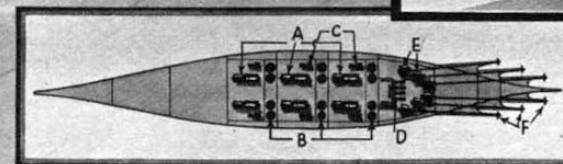
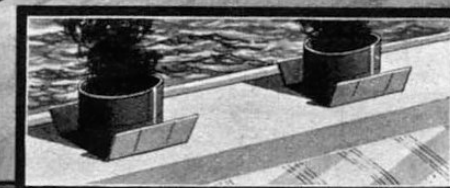


### KEY TO SECTIONAL VIEW

- |                                                    |                                                  |                                                           |
|----------------------------------------------------|--------------------------------------------------|-----------------------------------------------------------|
| 1. Whaleback                                       | 14. Funnel flaps                                 | 30. 3,500 kilowatt auxiliary turbo-generators (port side) |
| 2. Breakwater                                      | 15. Games deck                                   | 31. No. 1 power room                                      |
| 3. Navigating bridge                               | 16. Lounge                                       | 32. Oil fuel tanks                                        |
| 4. Air intake vents                                | 17. Lifeboats                                    | 33. No. 2 power room                                      |
| 5. Sliding docking wing in extended position       | 18. Drawing room                                 | 34. No. 3 power room                                      |
| 6. Telescopic steel mast                           | 19. Grill room                                   | 35. Control platform and switch boards                    |
| 7. Navigating lights                               | 20. State rooms                                  | 36. Motor exciter units                                   |
| 8. Glass roof to lounges, games deck, etc.         | 21. Stores                                       | 37. Propulsion motors of 66,600 h.p. each                 |
| 9. Gymnasium                                       | 22. Funnel uptake                                | 38. Port propellers                                       |
| 10. Draught tunnels                                | 23. Pantries                                     | 39. Exhaust pipe exit                                     |
| 11. Wireless gear                                  | 24. Restaurant                                   | 40. Clear decks aft                                       |
| 12. Retractable funnel stowed and gases forced aft | 25. Kitchens                                     | 41. Gases passing to exhaust pipes aft                    |
| 13. Top hamper                                     | 26. Bathrooms                                    |                                                           |
|                                                    | 27. Swimming pool                                |                                                           |
|                                                    | 28. 51,000 kilowatt turbo-generators (port side) |                                                           |
|                                                    | 29. Patent fuel valve boilers                    |                                                           |



(Below) View showing the retractable funnels extended for use in port or in a following wind.



(Left) Plan of machinery showing disposition of A, Turbo-generators; B, Patent fuel valve boilers; C, Auxiliary turbo-generators; D, Exciter units; E, Propulsion motors, and F, Propellers.



# Man on the Moon

AN EAGLE  
cutaway  
DRAWING

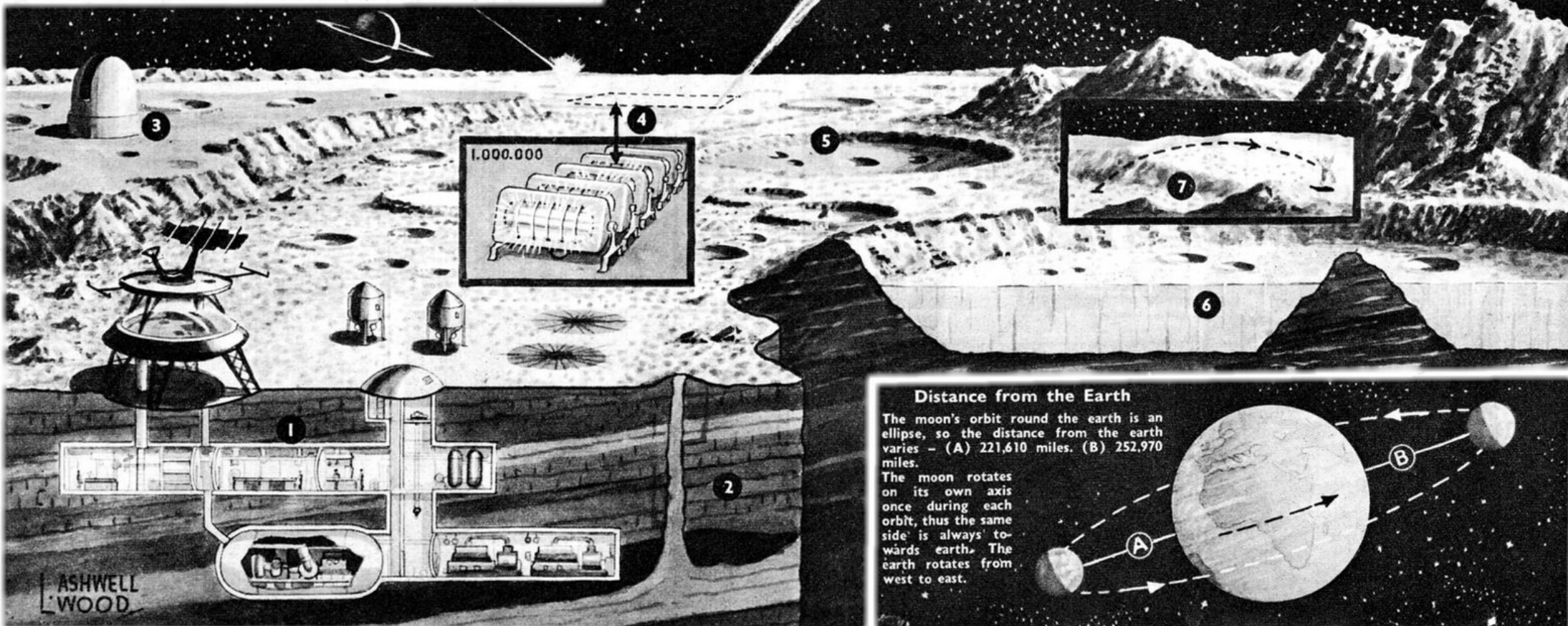
**EMPTY** and still – that's the verdict of the latest information about the moon. Empty because there appears to be no sign of vegetation or any tracks due to animal life – still because there is no atmosphere and sound cannot travel through a vacuum. Man's journey to the moon bounds startlingly forward from the realm of science fiction into science fact.

In this special EAGLE drawing, we show some of the aspects, compiled from leading scientists, of man's life on the moon if and when he reaches it.

## KEY TO NUMBERED ASPECTS

(1) The moon would certainly be a most uncomfortable place to live on, quietly baking at 220 degrees Fahrenheit – above the boiling point of water by day and minus 240 degrees at night. Thus man would have to take up permanent residence below the lunar surface, with galleries for living – power plants and oxygen generating systems. Extensive radar equipment above ground for spaceship guidance, etc. (2) The moon's geographical strata may be a source of mineral wealth. (3) Really large telescopes might be set up to make observations of the remoter parts of the universe unhampered by any atmosphere. (4) The sun's energy, falling on one square mile of the moon's surface, could run continuously about a million 1-kilowatt electric fires. (5) Some of the craters,

called washbowls, have a hole in the middle like a plug-hole. (6) There are probably 250,000 craters on the moon, large and small – many have been mapped and named. Clavius, for example, is 145 miles in diameter and 16,000 feet deep. Dust would lie only on the surface of the moon but, in the flat floor of the lunar craters, it may be miles thick. (7) Owing to lack of atmosphere and less gravity, man will be able to jump great distances. Quite a simple jump would carry him a distance of about 40 yards and three times his height. (8) To fetch and carry all the equipment necessary to place man permanently on the moon, a shuttle service of spaceships would have to be undertaken. (9) The earth to the man on the moon, would appear four times as large as the moon does to us. (10) Moon to same scale as seen by us.



## Distance from the Earth

The moon's orbit round the earth is an ellipse, so the distance from the earth varies – (A) 221,610 miles. (B) 252,970 miles.

The moon rotates on its own axis once during each orbit, thus the same side is always towards earth. The earth rotates from west to east.





# WORLD'S SLOWEST VEHICLE

*Will help man to reach the moon*

**I**N 1969—or possibly earlier—three astronauts will attempt the return journey to the moon in the Apollo/Saturn V rocket. Yet when they actually climb in, the rocket will have already travelled three miles—in three hours!

The rocket will have been assembled in one of the world's biggest buildings, at Complex 39 as it is known—an 80,000-acre site for launching Saturn rockets. Inside this 500-foot-high building, on the world's biggest vehicle, will be assembled various-sized Saturn rockets culminating in the one which will head for the moon.

Because the thousands of checks and re-checks on the vital systems that make up a successful launch must be carried out in as near as possible dust free and almost clinical conditions, it is essential that complete protection from the weather be available.

The building provides this weather-proof protection for assembly and fuelling. But some means had to be available to move the 365-foot, 3,000-ton rocket from the building to the launch area. The answer has appeared

in the amazing vehicle shown in these illustrations—the mobile launcher.

This consists of a crawler transporter with huge caterpillar tracks and surmounted by a 25-foot-high base box.

On this base box is erected the assembly platform and tower—18 storeys and 446 feet high, 160 feet long and 135 feet wide. On top of the tower is a crane capable of lifting 29 tons.

Once the rocket has been assembled on the base box, the engines of the crawler transporter are started up and the whole assembly moves at a snail's pace to the launching site.

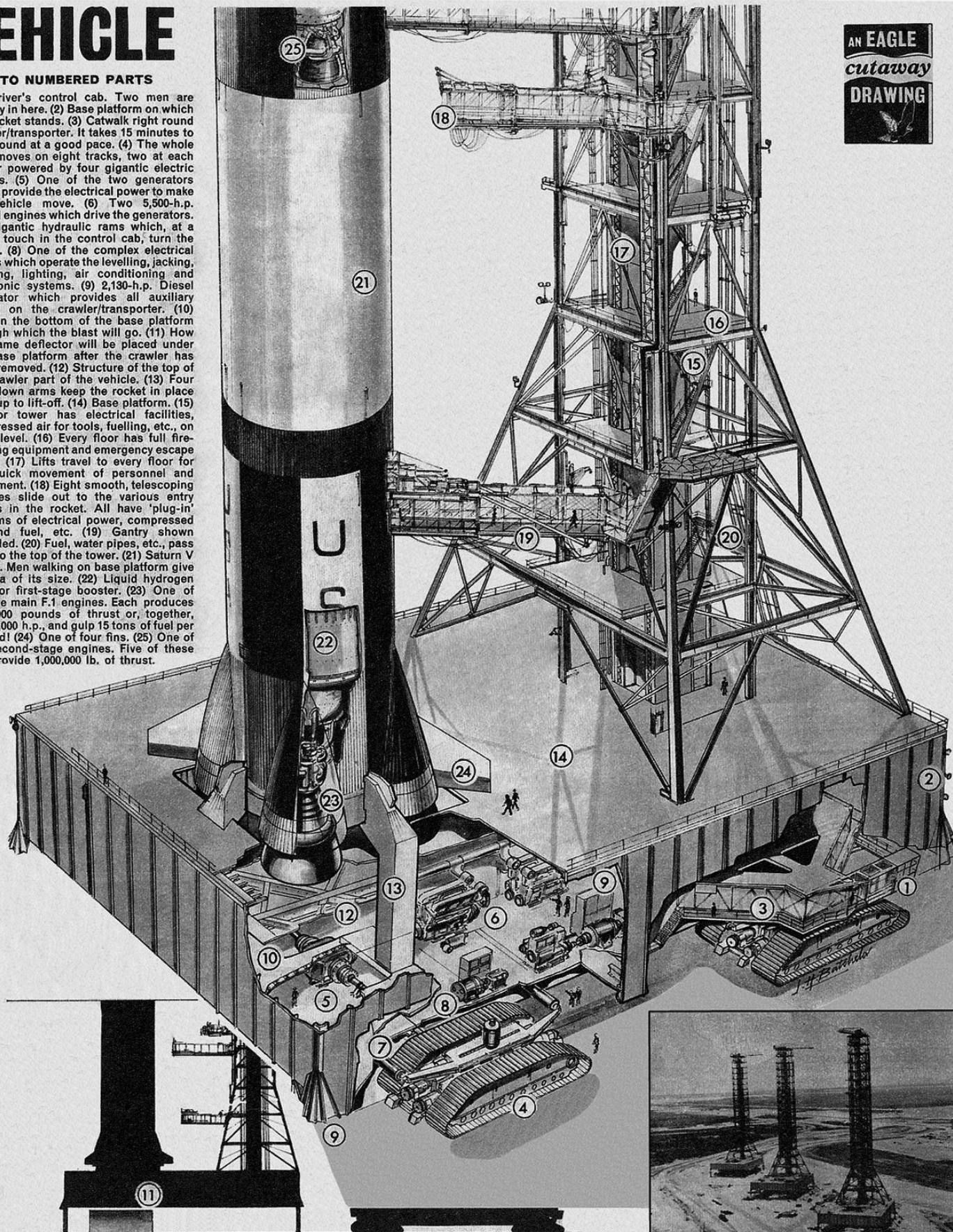
The crawler transporter is 131 feet long, 114 feet wide and weighs 6,000,000 lb. Without its load it can dash along at two miles an hour, but loaded with a fuelled rocket its speed is only one mile per hour!

Three of these crawler transporters have been built, each costing £4,000,000.

Complex 39 has cost £358,000,000—and the whole programme is costing nearer £1,000,000,000.

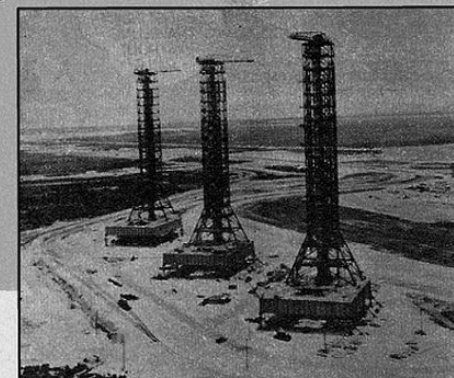
## KEY TO NUMBERED PARTS

(1) Driver's control cab. Two men are usually in here. (2) Base platform on which the rocket stands. (3) Catwalk right round crawler/transporter. It takes 15 minutes to walk round at a good pace. (4) The whole load moves on eight tracks, two at each corner powered by four gigantic electric motors. (5) One of the two generators which provide the electrical power to make the vehicle move. (6) Two 5,500-h.p. Diesel engines which drive the generators. (7) Gigantic hydraulic rams which, at a finger touch in the control cab, turn the tracks. (8) One of the complex electrical outfits which operate the levelling, jacking, steering, lighting, air conditioning and electronic systems. (9) 2,130-h.p. Diesel generator which provides all auxiliary power on the crawler/transporter. (10) Hole in the bottom of the base platform through which the blast will go. (11) How the flame deflector will be placed under the base platform after the crawler has been removed. (12) Structure of the top of the crawler part of the vehicle. (13) Four hold-down arms keep the rocket in place right up to lift-off. (14) Base platform. (15) 18-floor tower has electrical facilities, compressed air for tools, fuelling, etc., on every level. (16) Every floor has full fire-fighting equipment and emergency escape stairs. (17) Lifts travel to every floor for the quick movement of personnel and equipment. (18) Eight smooth, telescoping gantries slide out to the various entry panels in the rocket. All have 'plug-in' systems of electrical power, compressed air and fuel, etc. (19) Gantry shown extended. (20) Fuel, water pipes, etc., pass right to the top of the tower. (21) Saturn V rocket. Men walking on base platform give an idea of its size. (22) Liquid hydrogen tank for first-stage booster. (23) One of the five main F.1 engines. Each produces 1,500,000 pounds of thrust or, together, 32,000,000 h.p., and gulp 15 tons of fuel per second! (24) One of four fins. (25) One of J.2 second-stage engines. Five of these will provide 1,000,000 lb. of thrust.



The small silhouette sketch shows how the four corners of the 25-foot-high base box are jacked up once it is at the launching pad and the crawler part of the vehicle moves. A large flame deflector is then moved in to guide the flash away from the platform at blast off. At the same time, 30,000 gallons of cold water are fired at the flames.

AN EAGLE  
cutaway  
DRAWING



They're not exactly hurrying—but they're moving!



**The 1,000 m.p.h. atomic-jet:** Long-distance airliners would be pilotless and guided by radar and advanced electronics.

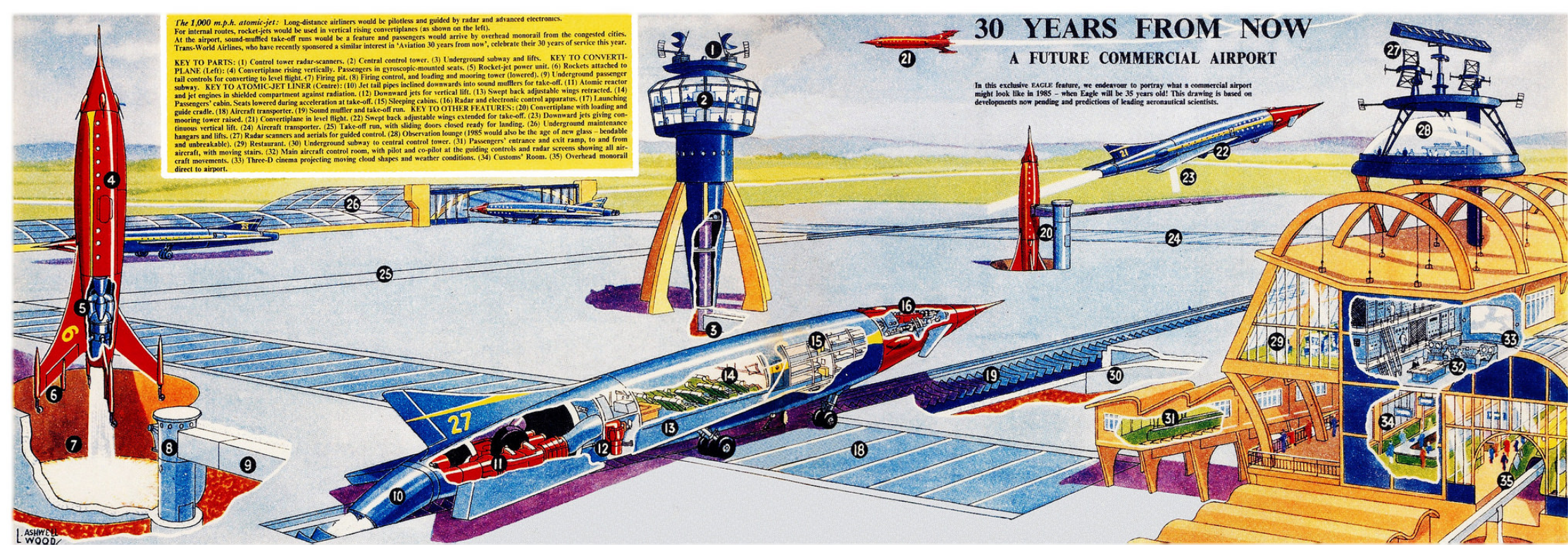
For internal routes, rocket-jets would be used in vertical rising convertiplanes (as shown on the left). At the airport, sound-muffled take-off runs would be a feature and passengers would arrive by overhead monorail from the congested cities. Trans-World Airlines, who have recently sponsored a similar interest in 'Aviation 30 years from now', celebrate their 30 years of service this year.

**KEY TO PARTS:** (1) Control tower radar-scanners, (2) Central control tower, (3) Underground subway and lifts. **KEY TO CONVERTIPLANE (Left):** (4) Convertiplane rising vertically. Passengers in gyroscopic-mounted seats. (5) Rocket-jet power unit. (6) Rockets attached to tail controls for converting to level flight. (7) Firing pit. (8) Firing control, and loading and mooring tower (lowered). (9) Underground passenger subway. **KEY TO ATOMIC-JET LINER (Centre):** (10) Jet tail pipes inclined downwards into sound mufflers for take-off. (11) Atomic reactor and jet engines in shielded compartment against radiation. (12) Downward jets for vertical lift. (13) Swept back adjustable wings retracted. (14) Passengers' cabin. Seats lowered during acceleration at take-off. (15) Sleeping cabins. (16) Radar and electronic control apparatus. (17) Launching guide cradle. (18) Aircraft transporter. (19) Sound muffler and take-off run. **KEY TO OTHER FEATURES:** (20) Convertiplane with loading and mooring tower raised. (21) Convertiplane in level flight. (22) Swept back adjustable wings extended for take-off. (23) Downward jets giving continuous vertical lift. (24) Aircraft transporter. (25) Take-off run, with sliding doors closed ready for landing. (26) Underground maintenance hangars and lifts. (27) Radar scanners and aerials for guided control. (28) Observation lounge (1985 would also be the age of new glass - bendable and unbreakable). (29) Restaurant. (30) Underground subway to central control tower. (31) Passengers' entrance and exit ramp, to and from aircraft, with moving stairs. (32) Main aircraft control room, with pilot and co-pilot at the guiding controls and radar screens showing all aircraft movements. (33) Three-D cinema projecting moving cloud shapes and weather conditions. (34) Customs' Room. (35) Overhead monorail direct to airport.

## 30 YEARS FROM NOW

### A FUTURE COMMERCIAL AIRPORT

In this exclusive EAGLE feature, we endeavour to portray what a commercial airport might look like in 1985 - when Eagle will be 35 years old! This drawing is based on developments now pending and predictions of leading aeronautical scientists.





# ONE WAY ONLY!

AN EAGLE  
cutaway  
DRAWING

**I**MAGINE being taken up in a machine with no wings and no engine to height of 45,000 feet and being dropped — at a speed just under the speed of sound! Not only that, the machine has had its weight nearly doubled by filling large tanks inside with water to make it fall faster!

This is what will be happening this autumn when National Aeronautics and Space Administration (N.A.S.A.) pilot, Milton Thompson, tests the 'lifting concept body' M.2 — F.2 designed and built by the Northrop Aircraft Corporation of California.

At the moment, space vehicles, after re-entering

the earth's atmosphere, fall by parachute into the sea — where dozens of expensive-to-run ships wait to pick them up. Northrop and N.A.S.A. are studying the possibility of the space vehicle breaking in two, and the two halves being landed at airfields in the U.S.; the space pilots becoming aeroplane pilots for the last part of their trip.

The small sketch shows how similar half a space vehicle and the M.2 — F.2 are. Small fins, most probably folding, would have to be designed and the outside shape of the vehicles would have to be modified to give a better aerodynamic shape.

This machine for test will travel under the gigantic wing of a B.52 bomber — the one which carries the X.15 — to a height of 45,000 feet. During the drop, 'chase planes' will photograph the flight and pilot Milton Thomas will record his impressions of the vehicle's flight. The water ballast will give a more realistic idea of a space vehicle's weight, but on approach to landing, this will be jettisoned by blowing gas into the tanks.

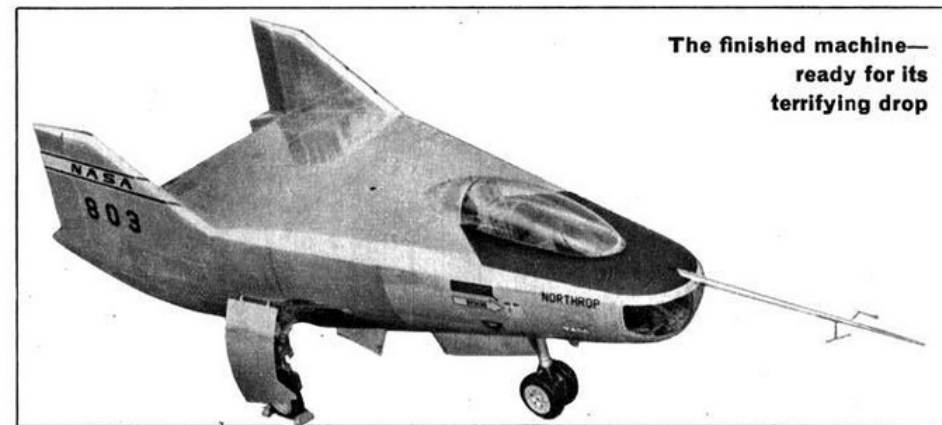
The landing speed has not been released, but it will be very high and the skill of the famous N.A.S.A. pilot will be put to extreme tests. He and U.S. Air Force Captain J. R. Gantry, who will also do test flights, must have iron nerves to fly a machine with no wings and no engine.

## DIMENSIONS:

Length: — 22 feet, 2 inches. Width: — 9 feet, 7 inches. Height: — 8 feet, 10 inches. Minimum Weight: — 4,600 lb. Maximum Weight: — (water ballast tanks full) 8,000 lb.

## KEY

(1) Pitot Head. (2) On landing approach, when the front of the machine is pointing upwards, pilot will look through nose glass panel. (3) Rudder pedals. Battery for anti-mist units situated between. (4) Pilot's ejection seat. (5) Ultra-high frequency transmitters/receivers. (6) Radio-compass. (7) Stability gyros. (8) Emergency batteries. (9) Main power-source battery. (10) Cockpit pressure air tank. (11) Undercarriage bay. (12) Nitrogen tank. (13) Hydrogen peroxide tank. When 12 and 13 are mixed, they cause gas pressure which will blow water out of 14, 15 and 16. This is on a similar principle to a soda syphon. (14) 198-gallon water ballast tank. (15 and 16) 123-gallon water ballast tanks. (17) Water jettison pipe. (18) Because the M.2 has no wings, roll control is gained from the split flaps on the upper rear edge of the body. A sideways push on the joystick lifts one half as shown, causing roll. A single full-width flap for slowing on approach and landing is fixed on the lower rear edge of the body. (19) Hydraulic rams to work rudders and all controls. (20) Fully retractable undercarriage.



The finished machine—  
ready for its  
terrifying drop



# DESTINATION moon PART ONE

Soon there will be no need for writers to imagine what it is like to travel to the Moon. Being built at this moment, in the U.S.A., is a vast, multi-stage rocket which will take two men to the Moon's surface so that first-hand information will be available.

This particular subject is being shown in two issues because of the size of the rocket, and the complexity of describing its functions.

A giant, two-stage rocket (Saturn) will fire a unit known as 'Apollo' into orbit far out from the Earth's surface. Apollo then comes into its own. This will take the astronauts on a journey which will make even Dan Dare take notice!

At the moment, dozens of firms are making parts and components for the Saturn/Apollo project.

New launching pads known as Launch Complex 39 are being built at Cape Kennedy. This plant is known as 'Moonport'. On these 30,000 acres of complicated installations, a building equivalent to 48 stories in height has been constructed. Inside, Saturn and Apollo will be assembled vertically after large components arrive in tank-landing ships, etc. Saturn and Apollo are actually built on a giant launch-rack which also supports an umbilical tower.

When the assembling is complete, a gigantic crawler-vehicle will pick up the rack and rocket and move it through the biggest door in the world (456 feet high). The 3,000-ton load will be carted the 2 miles with load-levelling hydraulic cylinders. Diesel generators, supplying electricity to motors driving eight tank-type tracks under the rack and vertical rocket, will certainly look an unusual sight. Once on the pad, the rocket will take on fuel.

Next week, we will show (1) stage-by-stage pictures of the three astronauts' progress into space; (2) transfer of two of the astronauts from command module to lunar exploration module; (3) lunar landing and blast off; (4) transfer in lunar orbit from lunar module back to command module and journey back to Earth. With both copies of EAGLE side by side, you will be able to follow the astronauts' adventures.

## SOME COMPARISONS

To give some idea of the vast size of Saturn V, two well-known buildings have been drawn. On the left, in red, is a silhouette of St. Paul's Cathedral (365 feet); then Saturn (350 feet). On the right, in black, is Nelson's Column, completely dwarfed. In fact, several Columns could be lost inside Saturn.

## KEY TO NUMBERED PARTS

(1) First-stage engines. On the centre line is one rigidly mounted engine. The other four, mounted in a square, can be moved in any direction for flight control. While developing the blast-off thrust of 7½ million pounds, or 3,350 tons, these thirty engines gulp down a cool 15 tons of fuel per second. These engines will lift the equivalent of 85 capsules of the type used by John Glenn during his orbits of the Earth! (2) Fins to help with guidance during flight through atmosphere. (3) 138 feet high, and 33 feet in diameter, the first-stage (containing fuel tank only). (4) Fuel-delivery pipes, through which a man could walk. (5) Kerosene fuel tank in stage one. (6) Liquid oxygen tank. Tunnels pass through kerosene tank to engines. (7) Second-stage engines. Five J.2. engines, using high-energy liquid hydrogen fuel, develops 200,000 pounds thrust and will burn 450 tons of fuel in 7 minutes. (8) Liquid oxygen, known as 'LOX', accounts for one quarter of the second-stage fuel capacity. Because of its low temperature (minus 297°F.), it is of great danger to most materials and tends to boil into a useless gas. Heavy insulation helps to avoid this. (9) Liquid hydrogen tank. This liquid is even colder than LOX (-423°F.) This is so cold that it would burn a man to a cinder in seconds! These two produce more thrust per pound than any other chemicals. (10) Stage 3. One J.2. engine, using the same type of fuel as Stage 2, will use 230,000 lb. of fuel in 7 minutes. Everything ahead of this section will actually travel to the Moon. (11) Astronauts' control centre, etc. This is shown in greater detail on the right.



AN EAGLE  
cutaway  
DRAWING

(A) It is hoped that this stage will not have to be used. It is the solid-fuel rocket which will tow the astronauts out of harm's-way if, during blast-off, Saturn has to be destroyed.

(B) Command module. In this, the astronauts will travel to and from the Moon. On specially-designed couches, they will be able to withstand the tremendous G-forces following blast-off. (C) Heavy ceramic heat-shield which will protect the occupants during re-entry. (D) Retro-rockets. These keep altitude of rocket correct. When one side fires down, the opposite side will fire up. Gyros will fire them automatically. (E) The rocket motor and fuel tanks which will blast the astronauts back to Earth from the orbit round the Moon.

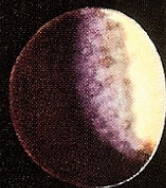
(F) Lunar exploration module, or 'LEM'. The most important piece of equipment aboard. After transferring to this, the astronauts will actually land on the Moon in this machine. Perched on top of Stage-3 tanks, it is a home, laboratory, miniature Cape Kennedy and satellite all rolled into one.

(G) Retro-rockets used during landing and blast-off to keep LEM level. (H) Control section with large windows to enable good landing ground to be picked. (I) Aerials, etc. (J) Rocket motors in the base make for a soft landing. After four days on the Moon, this base section parts from the upper section to form a blast-off base. (K) Stalk-like legs on which LEM will land. (L) Top of Stage-3 fuel tanks.



# DESTINATION moon PART TWO

Last week we described the giant Saturn two-stage rocket which will fire APOLLO, containing three astronauts, into orbit around the Earth. In this issue, we trace the stage-by-stage adventures of the astronauts from the moment of blast-off to the point of recovery.

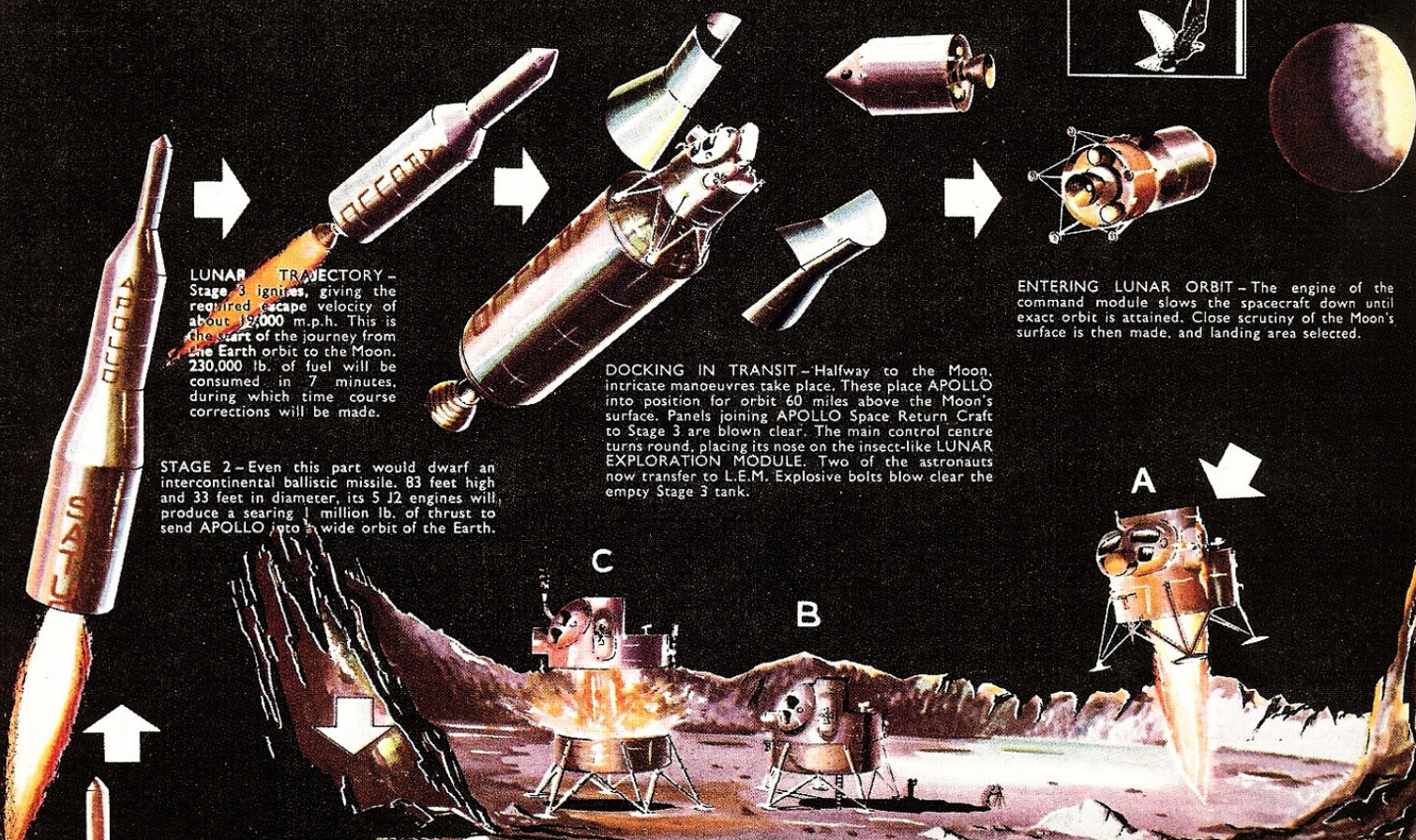


**LUNAR TRAJECTORY** - Stage 3 ignites, giving the required escape velocity of about 19,000 m.p.h. This is the start of the journey from the Earth orbit to the Moon. 230,000 lb. of fuel will be consumed in 7 minutes, during which time course corrections will be made.

**STAGE 2** - Even this part would dwarf an intercontinental ballistic missile. 83 feet high and 33 feet in diameter, its 5 J2 engines will produce a searing 1 million lb. of thrust to send APOLLO into a wide orbit of the Earth.

**DOCKING IN TRANSIT** - Halfway to the Moon, intricate manoeuvres take place. These place APOLLO into position for orbit 60 miles above the Moon's surface. Panels joining APOLLO Space Return Craft to Stage 3 are blown clear. The main control centre turns round, placing its nose on the insect-like LUNAR EXPLORATION MODULE. Two of the astronauts now transfer to L.E.M. Explosive bolts blow clear the empty Stage 3 tank.

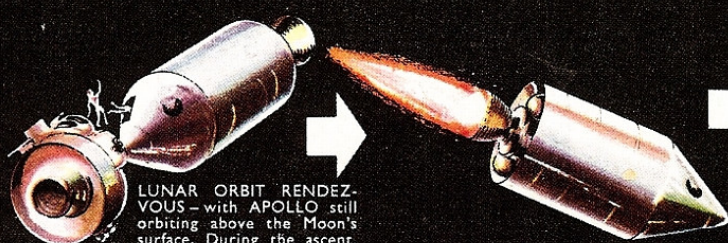
**ENTERING LUNAR ORBIT** - The engine of the command module slows the spacecraft down until exact orbit is attained. Close scrutiny of the Moon's surface is then made, and landing area selected.



(C) **LUNAR BLAST OFF** - Only the upper portion of L.E.M. leaves the Moon. The now-exhausted lower half being used as a miniature Cape Kennedy. (B) The two astronauts on the

Moon will spend two to four days carrying out scientific tests and making many measurements while the third man will carry on orbiting the Moon, keeping a very close watch on things.

**LANDING MANOEUVRE (A)** - L.E.M. decelerates from orbit towards the selected landing site. The large glass area in L.E.M. enables the astronauts to bring the vehicle down very accurately. With shock-absorbing legs extended, L.E.M. descends to within 100 feet of the Moon's surface. It will be able to hover for one minute in order to pick the best touchdown point.



**LUNAR ORBIT RENDEZ-VOUS** - with APOLLO still orbiting above the Moon's surface. During the ascent, radar contact is maintained until the two vehicles join together and the astronauts transfer back to APOLLO command vehicle.

**LUNAR ORBIT BLAST OFF** - The 3 astronauts set the remaining parts of Saturn/APOLLO in motion after a thorough check-over. In just a few minutes, the fuel tanks are empty - enough speed having been attained.



Instrumentation and dead engines are jettisoned, leaving only the comparatively small point of the gigantic Saturn/APOLLO spacecraft.



**BLAST OFF** - Standing 350 feet high and weighing 6 million lb., Saturn blasts the 3 astronauts through the atmosphere. The first stage will shoot its payload into orbit - thus bringing about the beginning of a journey dreamed about for a thousand years.



**RECOVERY** - Hundreds of aircraft and ground teams will be standing by hours before to release the astronauts from their 'oven'. Now the work really begins - exhaustive medical checks and analysing of scientific data. This will take months. When will it happen? Within 5 years. You will see the first man on the Moon most probably before you leave school.

**GENTLE LET DOWN** - on the end of 3 giant striped parachutes which open at 10,000 feet, bringing back 3 very brave men from a 500,000-mile journey to a gentle bump-down in the Nevada desert.

The craft is turned so that its ceramic heat shield will lead on to the Earth's atmosphere at 25,000 m.p.h.

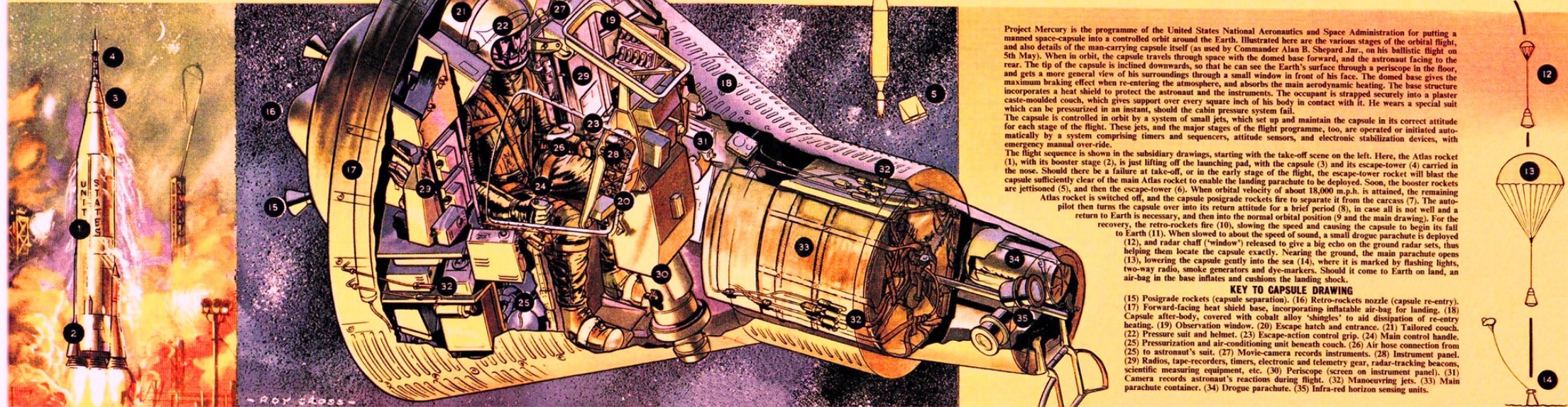


**RE-ENTRY** - Heat of ten times the temperatures encountered by the first manned satellite flights will be generated by the re-entry. This is the most dangerous part of the whole journey.

BATCHLOR



# PROJECT MERCURY



Project Mercury is the programme of the United States National Aeronautics and Space Administration for putting a manned space-capsule into a controlled orbit around the Earth. Illustrated here are the various stages of the orbital flight, and also details of the man-carrying capsule itself (as used by Commander Alan B. Shepard Jr., on his ballistic flight on 5th May). When in orbit, the capsule travels through space with the domed base forward, and the astronaut facing to the rear. The tip of the capsule is inclined downwards, so that he can see the Earth's surface through a periscope in the floor, and gets a more general view of his surroundings through a small window in front of his face. The domed base gives the maximum braking effect when re-entering the atmosphere, and absorbs the main aerodynamic heating. The base structure incorporates a heat shield to protect the astronaut and the instruments. The occupant is strapped securely into a plaster caste-moulded couch, which gives support over every square inch of his body in contact with it. He wears a special suit which can be pressurized in an instant, should the cabin pressure system fail. The capsule is controlled in orbit by a system of small jets, which set up and maintain the capsule in its correct attitude for each stage of the flight. These jets, and the major stages of the flight programme, too, are operated or initiated automatically by a system comprising timers and sequencers, attitude sensors, and electronic stabilization devices, with emergency manual over-ride.

The flight sequence is shown in the subsidiary drawings, starting with the take-off scene on the left. Here, the Atlas rocket (1), with its booster stage (2), is just lifting off the launching pad, with the capsule (3) and its escape-tower (4) carried in the nose. Should there be a failure at take-off, or in the early stage of the flight, the escape-tower rocket will blast the capsule sufficiently clear of the main Atlas rocket to enable the landing parachute to be deployed. Soon, the booster rockets are jettisoned (5), and then the escape-tower (6). When orbital velocity of about 18,000 m.p.h. is attained, the remaining Atlas rocket is switched off, and the capsule posigrade rockets fire to separate it from the carcass (7). The auto-pilot then turns the capsule over into its return attitude for a brief period (8), in case all is not well and a return to Earth is necessary, and then into the normal orbital position (9 and the main drawing). For the recovery, the retro-rockets fire (10), slowing the speed and causing the capsule to begin its fall to Earth (11). When slowed to about the speed of sound, a small drogue parachute is deployed (12), and radar chaff ('window') released to give a big echo on the ground radar sets, thus helping them locate the capsule exactly. Nearing the ground, the main parachute opens (13), lowering the capsule gently into the sea (14), where it is marked by flashing lights, two-way radio, smoke generators and dye-markers. Should it come to Earth on land, an air-bag in the base inflates and cushions the landing shock.

## KEY TO CAPSULE DRAWING

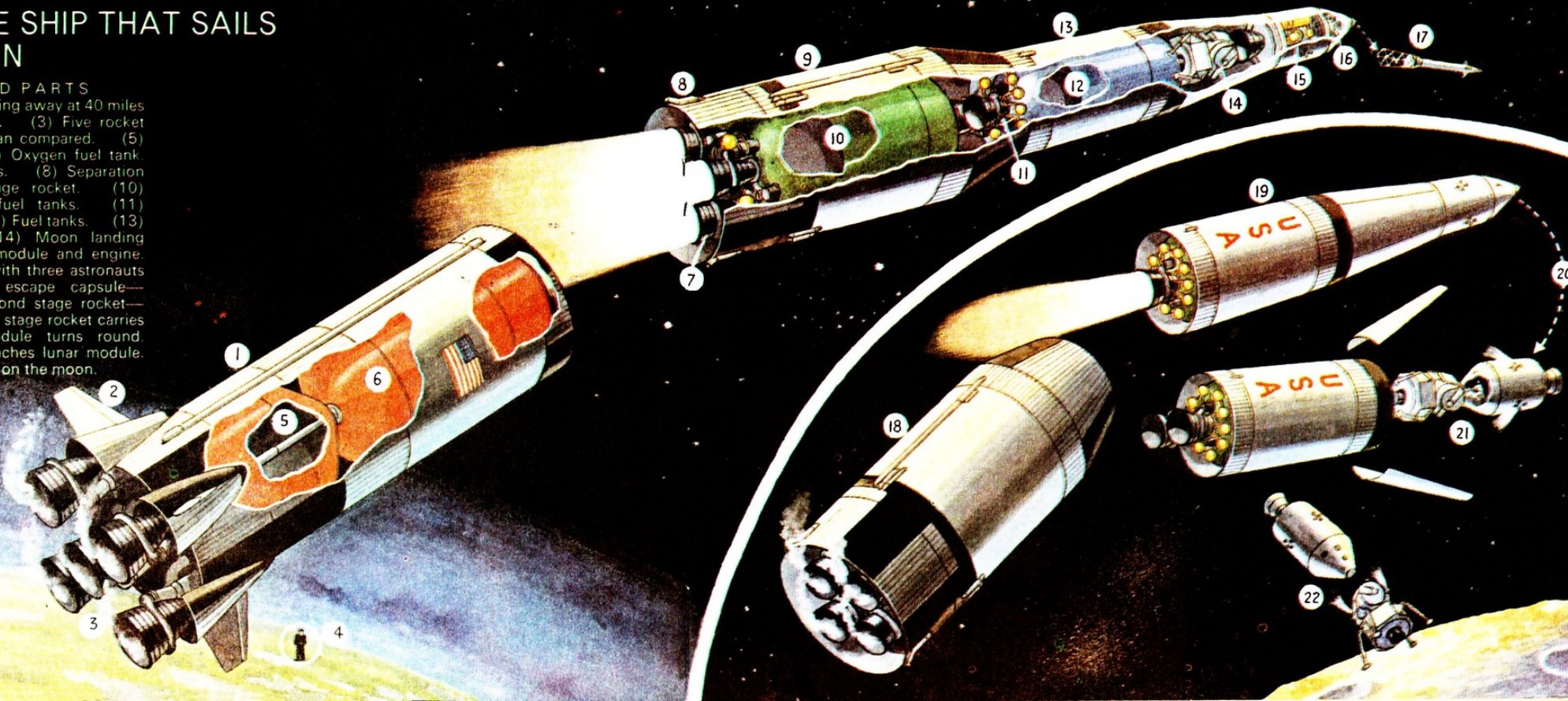
(15) Posigrade rockets (capsule separation). (16) Retro-rockets nozzle (capsule re-entry). (17) Forward-facing heat shield base, incorporating inflatable air-bag for landing. (18) Capsule after-body, covered with cobalt alloy 'shingles' to aid dissipation of re-entry heating. (19) Observation window. (20) Escape hatch and entrance. (21) Tailored couch. (22) Pressure suit and helmet. (23) Escape-action control grip. (24) Main control handle. (25) Pressurization and air-conditioning unit beneath couch. (26) Air hose connection from (25) to astronaut's suit. (27) Movie-camera records instruments. (28) Instrument panel. (29) Radios, tape-recorders, timers, electronic and telemetry gear, radar-tracking beacons, scientific measuring equipment, etc. (30) Periscope (screen on instrument panel). (31) Camera records astronaut's reactions during flight. (32) Manoeuvring jets. (33) Main parachute container. (34) Drogue parachute. (35) Infra-red horizon sensing units.



# Saturn 5—THE SHIP THAT SAILS TO THE MOON

## KEY TO NUMBERED PARTS

(1) First stage rocket—falling away at 40 miles up. (2) Stabilising fins. (3) Five rocket engines. (4) Size of man compared. (5) Kerosene fuel tank. (6) Oxygen fuel tank. (7) Second stage engines. (8) Separation bolts. (9) Second stage rocket. (10) Oxygen and hydrogen fuel tanks. (11) Third stage engines. (12) Fuel tanks. (13) Third stage rocket. (14) Moon landing module. (15) Service module and engine. (16) Command module with three astronauts inside. (17) Launch escape capsule—falling away. (18) Second stage rocket—falling away. (19) Third stage rocket carries on. (20) Service module turns round. (21) Service module detaches lunar module. (22) Lunar module landed on the moon.



ASHWELL  
WOOD



## INSIDE STORY

# The Slow Crawl To Blast-Off!

Huge space vehicles are carried at a snail's pace to their launching pad by a mammoth transporter

TWO years of delays, due to technical and engineering tests, have caused repeated holdups to America's space shuttle project — a system employing recoverable, and therefore, reusable spacecraft. However, the space shuttle now seems set for its maiden voyage in space next February.

Space craft launched from Cape Kennedy are assembled five kilometres from the launch pad in the Vertical Assembly Building (VAB), which is the largest building in the world. Inside this, four Saturn 5 rockets are assembled simultaneously.

To take the shuttle to its launching pad, the crawler transporter, a tracked vehicle, will be inserted under the mobile launching platform. Bearing its mighty load, the transporter will creep to its destination at a speed of about one-and-a-half kilometres an hour.

The crawler is controlled from two driving cabs at diagonally opposite corners of the vehicle. Movement, levelling and equalising of the load are directed from here, and winds of up to 48 knots blowing on the vertical load can be compensated for.

Each of the four crawler units is driven by four motors. So manoeuvrable are these crawlers in their ability to pivot, that the load can be turned in a crablike movement.

Shown beside London's Post Office Tower for a comparison of their heights, are the vehicle assembly building and the crawler transporter.

Smooth stopping is obtainable with the disc brakes on the drive shafts, which operate automatically if any motor breaks down.

The crawler's two parts, chassis and platform, are carried on steel-link caterpillar tracks like a tank's, but each link weighs about a ton.

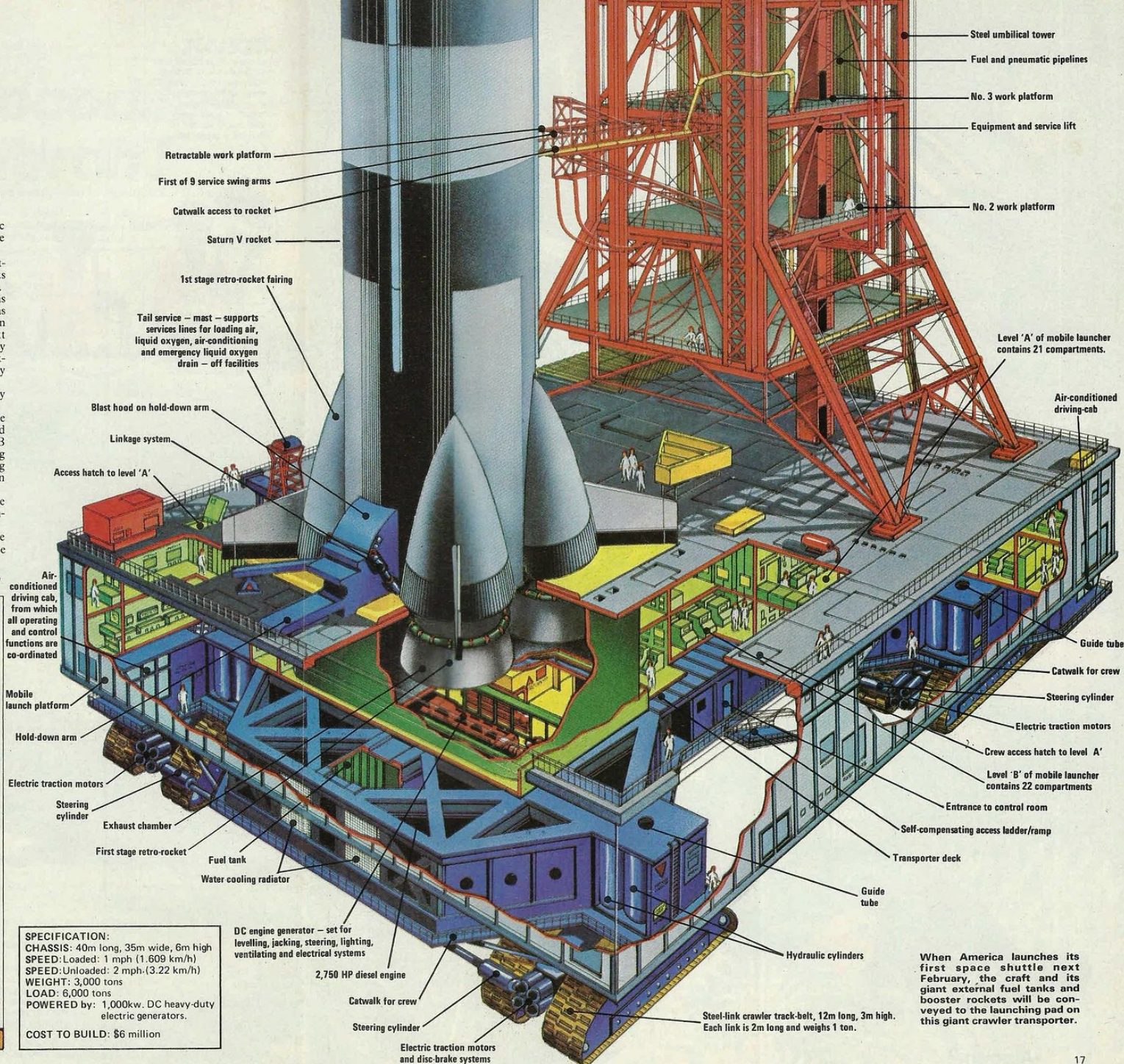
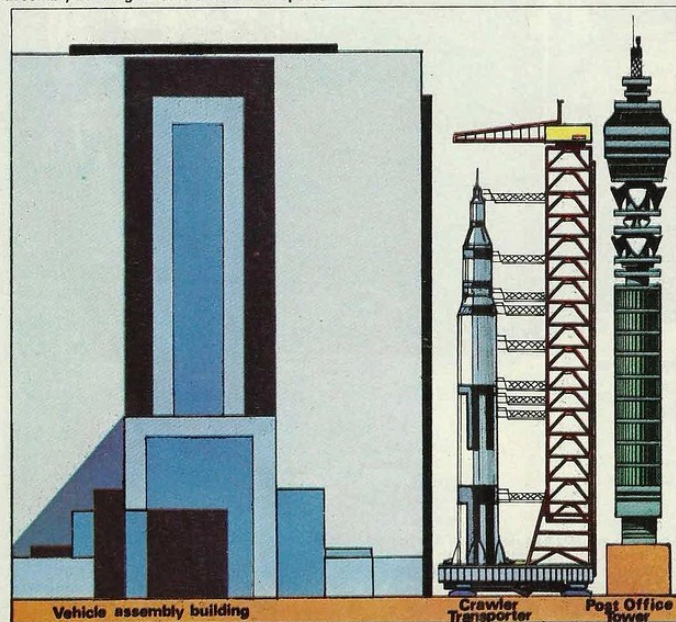
The first time the crawler transporter was used on a full-scale Apollo-Saturn 5 vehicle was when it rolled out a 500F (a full-scale moon landing vehicle) on 25th May, 1966, at Merritt Island at the Kennedy Space Centre, exactly five years after President Kennedy had committed the USA to a manned lunar landing by 1969, which was eventually achieved.

The crawler transporter was subsequently used for all the Apollo missions.

Like the Apollo-Saturn 5 vehicle, the space shuttle and its giant external fuel tanks and booster rockets will be built upright in the VAB on a mobile launching platform. The launching platform will be jacked up on six supporting pedestals and the crawler eased into position for accepting the load.

At the Kennedy Space Centre much of the equipment used for the moon flights was assembled and launched with crawler transporter.

These flights were vital to America's space programme — and just as important will be the launching of the space shuttle next February.

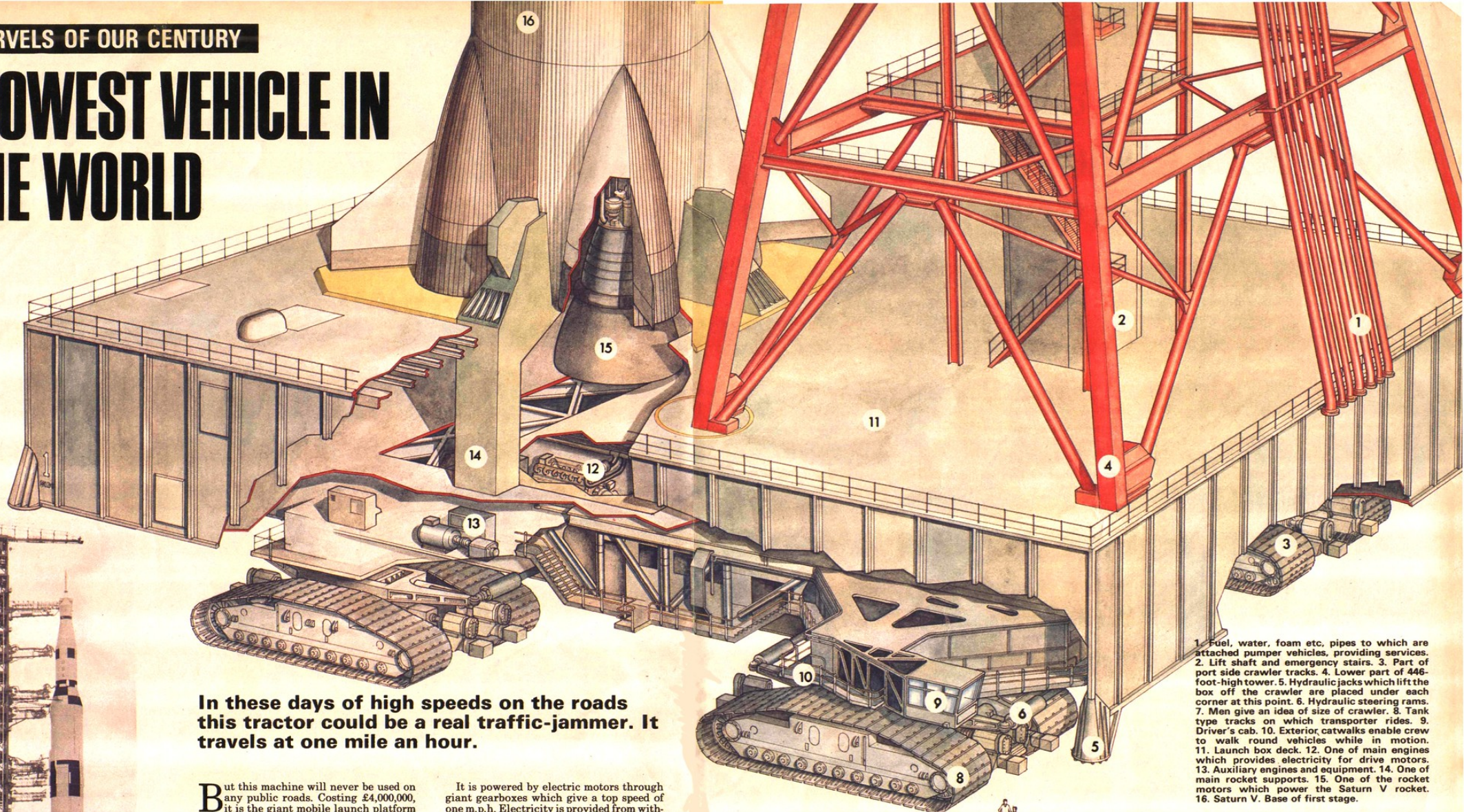


**SPECIFICATION:**  
CHASSIS: 40m long, 35m wide, 6m high  
SPEED: Loaded: 1 mph (1.609 km/h)  
SPEED: Unloaded: 2 mph (3.22 km/h)  
WEIGHT: 3,000 tons  
LOAD: 6,000 tons  
POWERED by: 1,000kw. DC heavy-duty electric generators.  
COST TO BUILD: \$6 million

When America launches its first space shuttle next February, the craft and its giant external fuel tanks and booster rockets will be conveyed to the launching pad on this giant crawler transporter.



# SLOWEST VEHICLE IN THE WORLD



**In these days of high speeds on the roads this tractor could be a real traffic-jammer. It travels at one mile an hour.**

But this machine will never be used on any public roads. Costing £4,000,000, it is the giant mobile launch platform used to help the 365-foot Saturn rockets on their way to the Moon.

In the photograph on the left is the vehicle with a Saturn rocket in place slowly rolling out of the huge building where it was assembled on the mobile launcher.

Inside the building, the rocket is assembled, all the complicated systems are put in, everything is checked a hundred—yes a hundred—times. The rocket is fuelled and made within one per cent of being ready. And this is where the mobile launcher comes in.

It is powered by electric motors through giant gearboxes which give a top speed of one m.p.h. Electricity is provided from within the vehicle itself by generators driven by a pair of 5,500 h.p. diesel engines. Hydraulic rams turn the tracks during the three-mile, three-hour journey to the launch site.

On top of the crawler part of the transporter is a box, 25 feet high, 160 feet long and 135 feet wide. At each corner is a hydraulic jack which, when in position, will lift the box, rocket and tower clear of the crawler. The crawler is then driven clear of the blast from the rocket.

When the rocket has been fired and the

charred box cooled, the crawler is driven back under the box, the hydraulic jacks are lowered and the box goes back for repainting and another rocket.

Why cannot the rocket be assembled on the spot from which it is fired, you ask. A modern rocket system like the Saturn V must be built in almost clinical conditions with humidity and temperature controlled very carefully.

One tiny droplet of moisture in the wrong place, say in an electrical junction

box, could mean a short circuit out in space causing a disaster. Who knows, just this might have set up the reaction which caused Apollo 13 to become such a near miss disaster.

On top of the launch "box" is a tower with 18 floors, enabling crew men and specialists to attend to the hundreds of systems needing constant checking and attention. The tower provides all the services that could be required during the last four hours before blast off. Lifts, water,

electricity, power tools, fire fighting equipment of every sort, cold air, hot air, "top up" fuels—in fact everything the engineers could want to get the rocket safely away.

The tower is topped by a crane which is used to lift the sections of the giant rocket into place. On top of the crane is a flashing red light—446 feet above the ground.

By the way, when the transporter is returning from the launch site empty it really gets speed up and has been known to dash along at two m.p.h.

1. Fuel, water, foam etc. pipes to which are attached pumper vehicles, providing services.
2. Lift shaft and emergency stairs.
3. Part of port side crawler tracks.
4. Lower part of 446-foot-high tower.
5. Hydraulic jacks which lift the box off the crawler are placed under each corner at this point.
6. Hydraulic steering rams.
7. Men give an idea of size of crawler.
8. Tank type tracks on which transporter rides.
9. Driver's cab.
10. Exterior catwalks enable crew to walk round vehicles while in motion.
11. Launch box deck.
12. One of main engines which provides electricity for drive motors.
13. Auxiliary engines and equipment.
14. One of main rocket supports.
15. One of the rocket motors which power the Saturn V rocket.
16. Saturn V. Base of first stage.



# A NEW BRITISH SPACE VEHICLE

**T**HREE years of work by research teams at the British Aircraft Corporation's aerospace department at Warton, near Preston in Lancashire, has produced an idea which is regarded as a breakthrough in future space travel.

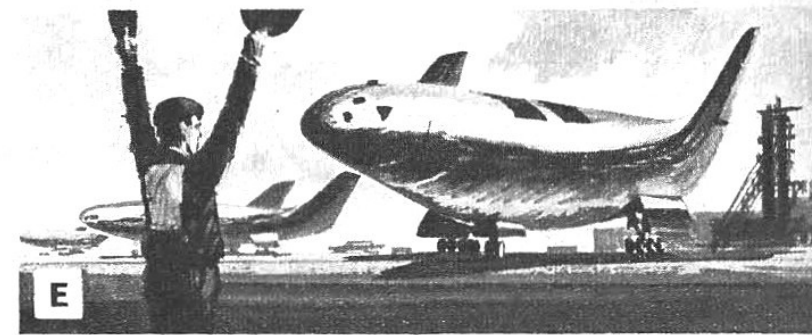
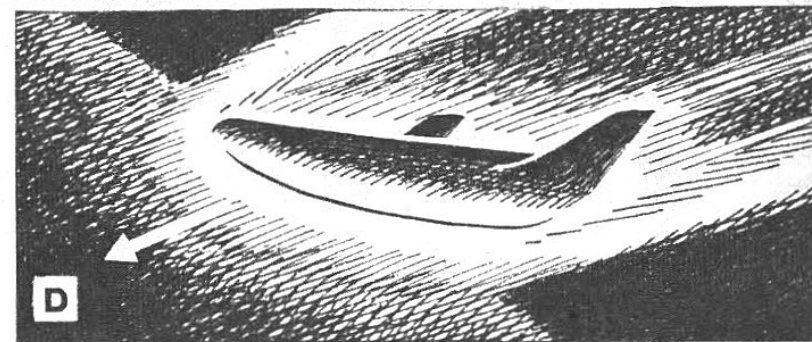
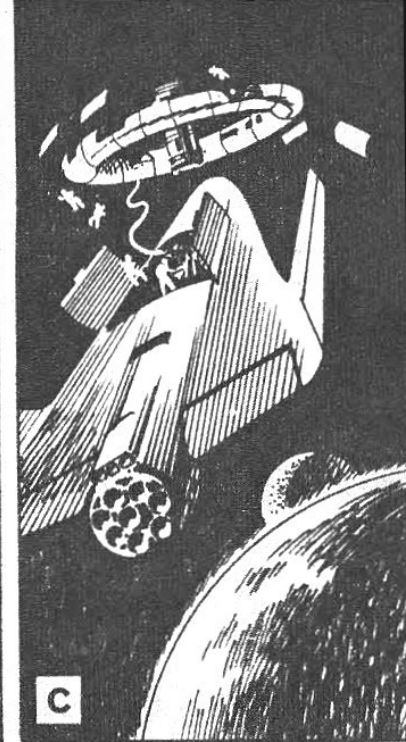
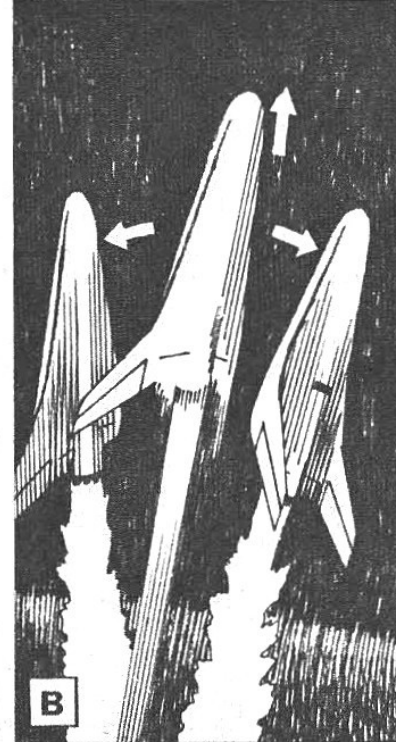
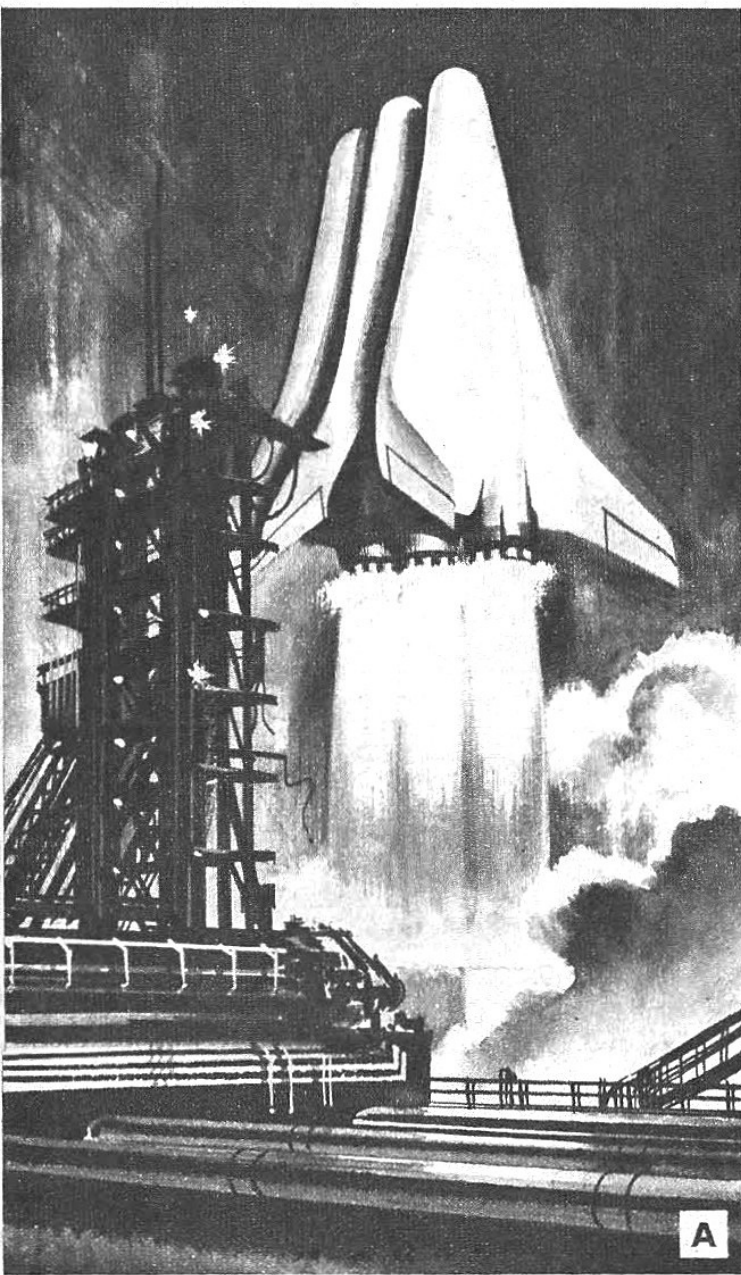
One of the disadvantages of the present satellite vehicles which the Americans have been putting into orbit is that the booster rockets used to hurl them into space became useless pieces of debris after fulfilling their purpose. If some way could be found of using the propulsion unit over and over again, the saving in time and money would be enormous.

Now, British scientists and technicians of B.A.C. have come up with an idea which has been code-named 'Mustard' (Multi-Unit Space Transport and Recovery Device), and it could become Europe's standard space vehicle in the 1980s.

It is made up of three identical manned units stacked together (see left). The two outer units boost the middle one to a speed of 4,530 m.p.h. and then break away and return to base. Using its own engine and fuel, the centre unit speeds on into orbit, carries out its task and then re-enters the atmosphere, making an aerodynamic landing near its launching site.

The propellants used by 'Mustard' would be liquid hydrogen and liquid oxygen. The three rocket motors are first fed with fuel from the tanks of the two outer units. These become exhausted at an altitude of about 150,000 feet, but small hydrogen-fuelled turbo-jet engines enable them to return and land at a speed of about 100 m.p.h.

Our artist's drawings show (A) a Mustard unit blasting off, all motors firing. (B) The outer units breaking away in the upper layers of the atmosphere. (C) Centre Unit going into orbit with its payload. (D) Unit re-entering the earth's atmosphere and (E) Landing on a normal aircraft runway.





# Built To Beat The Barrier

Modern aerotechnology and revolutionary materials make it possible for Concorde to fly at twice the speed of sound

**L**ONDON to New York in just under 3½ hours at twice the speed of sound... only one aircraft is regularly performing this feat. And that is Concorde, the supersonic airliner, developed jointly by Britain and France.

As it soars through the air powered by its four mighty Olympus engines, the centre of lift moves towards the rear. To avoid the tail end of the plane lifting and causing greater drag, which would make the plane harder to control, fuel is pumped between the main tanks and forward and aft trim tanks.

This is only one of the ways in which Concorde differs from subsonic aircraft. Another is in

the use in the engines of metals which can withstand extremely high temperatures. Titanium is used for the low-pressure compressor and the first stages of the high-pressure compressor where the temperature reaches 550 deg. C. There are even higher temperatures back in the engine, and nickel-based alloys are used here.

Concorde's history goes back to 1962 when Britain and France signed an agreement to design and manufacture Concorde jointly. The prototype first flew on 2nd March, 1969, and the first flights with fare-paying passengers were on 21st January, 1976, from London to Bahrain, and Paris to Rio de Janeiro.

The first flights to the USA were made to Dulles Airport, Washington. Then, after a long legal battle, came the authorisation to fly to New York.

People seeing the aircraft for the first time noticed the distinctive feature of its droop nose. To avoid obscuring the view of the flight crew on landing and take-off, the nose is lowered.

At supersonic speeds, the

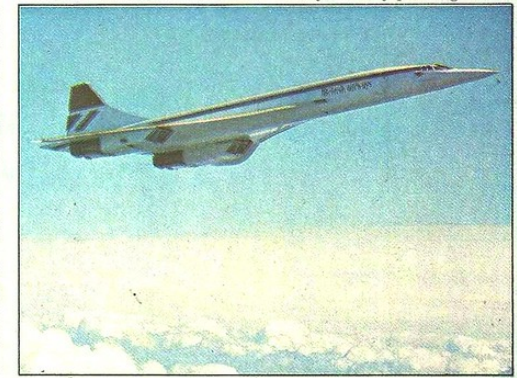
nose is raised, together with a visor which, in high speed flight, protects the flight deck windows.

Before it could go into service, Concorde had to be tested in every type of operating environment. Two prototypes and two pre-production Concorde were made.

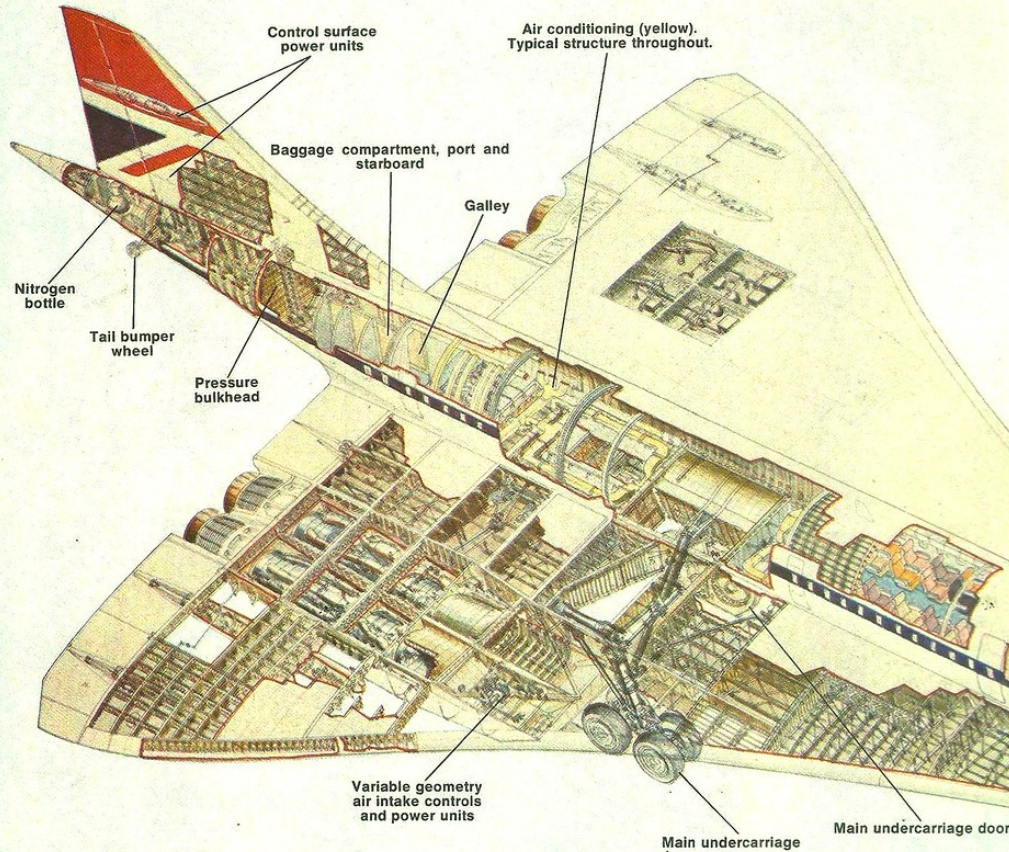
Measurements were made of

3,000 different things, including pressures, temperatures, accelerations and altitudes. All of these measurements were recorded on magnetic tape in the plane for analysis on the ground later.

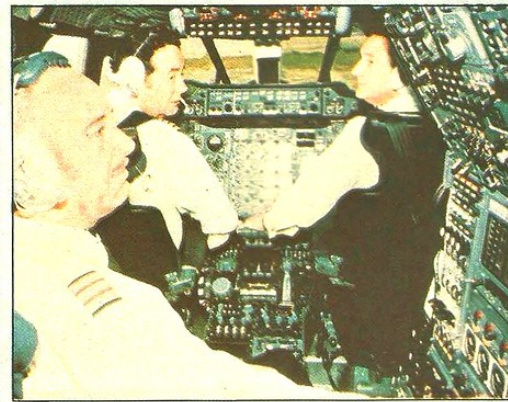
Tests of many other parts of the aircraft were monitored before the craft was considered ready to carry passengers.



As lovely as a bird in flight, the slim and graceful Concorde prepares to pierce the sound barrier.



All the features which make a great plane are shown in the detailed drawing above. An idea of the Concorde's size can be gauged by comparing it with the fuelling vehicle, bottom left. Below is the flight deck with its mass of dials and controls.





It moves underwater with periscope raised, then its ballast is expelled and the craft surfaces. Its water skids are drawn back and a powerful turbojet pushes it towards the skies. Then its skids come out again, it touches down on the surface again and floats for a moment as it takes in water (ballast) before submerging.

# HERE COMES THE FLYING SUBMARINE

A submarine that flies has long been a popular favourite in comic stories and on children's television programmes. It is very simple to write one into a script, then ask an artist to illustrate or a puppeteer to manipulate one. But how on earth do you make the real thing?

This problem has fascinated men for many years, and several nations have wrestled with the idea of producing a craft that could fly, float, submerge, surface, take off and fly again. It was a difficult problem to solve—for obvious reasons.

A submarine must be waterproof, airtight and have special engines to drive it along beneath the waves. Also it is usually heavy.

On the other hand, a plane needs to be sleek and fairly lightweight, and certainly there has never been designed an aeroplane with watertight engines.

What was right for a submarine, it

seemed, was anything but right for a plane.

However, something that can sort out the contradiction in designs is at last in the wind—and the water.

In recent years, an enormous amount of research has been put into the American space programme, and many new techniques and materials have been developed.

## Sensational Craft

An American engineer by the name of Donald V. Reid has borrowed some of these latest ideas and developments from space—in particular an improved engine design and a new highly resistant lightweight material—and has constructed the prototype of an aeroplane that can both fly and travel under water.

As yet, it's all very secret. Not even for *WORLD OF WONDER* are the Americans going to divulge the actual 'ingredients' of this sensational craft. All the technical data is being kept very close to the chest, though since this is usual in the case of all

new aircraft, it is even more to be expected in the case of such a revolutionary concept.

The greatest value of such a craft would without doubt be military, for with such a machine a pilot could carry out the most effective of surprise attacks.

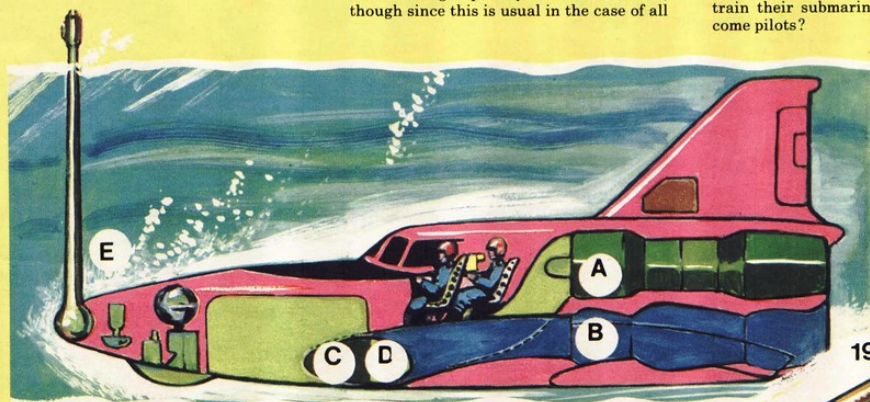
He could approach his target under the water, make a sudden unexpected take-off, strike and immediately afterwards submerge and be reasonably safe from counter-attack.

At present, forecasts for this submarine aircraft are that it will fly at about 500-550 mph and be able to travel at some 20-25 mph underwater.

Scientists in the Soviet Union are also working feverishly to turn out a similar multi-use plane.

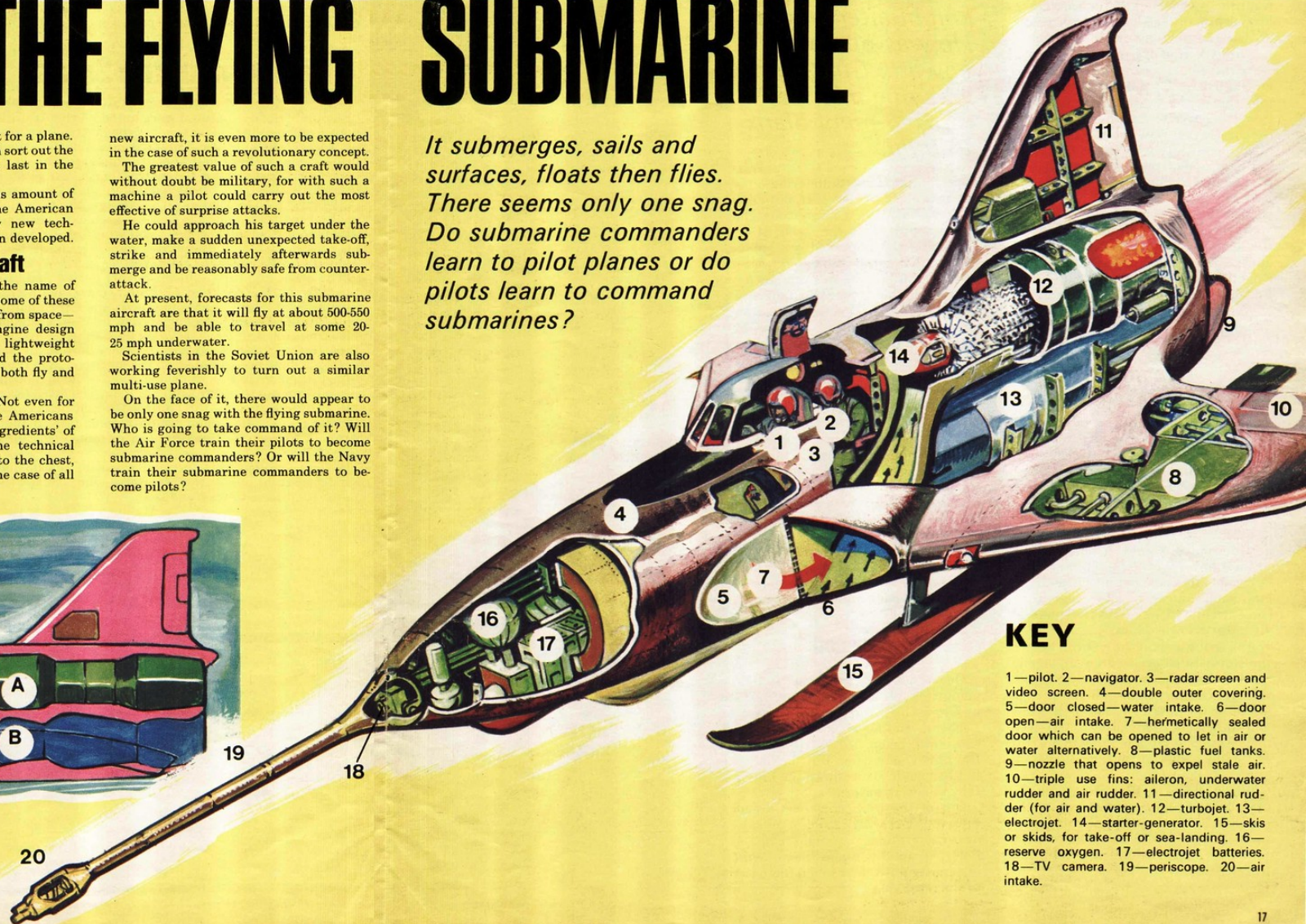
On the face of it, there would appear to be only one snag with the flying submarine. Who is going to take command of it? Will the Air Force train their pilots to become submarine commanders? Or will the Navy train their submarine commanders to become pilots?

*It submerges, sails and surfaces, floats then flies. There seems only one snag. Do submarine commanders learn to pilot planes or do pilots learn to command submarines?*



## HOW IT NAVIGATES UNDERWATER

- A—turbojet
- B—electrojet
- C—air intake—with door closed
- D—air intake open for the electrojet
- E—periscope extended for navigation underwater



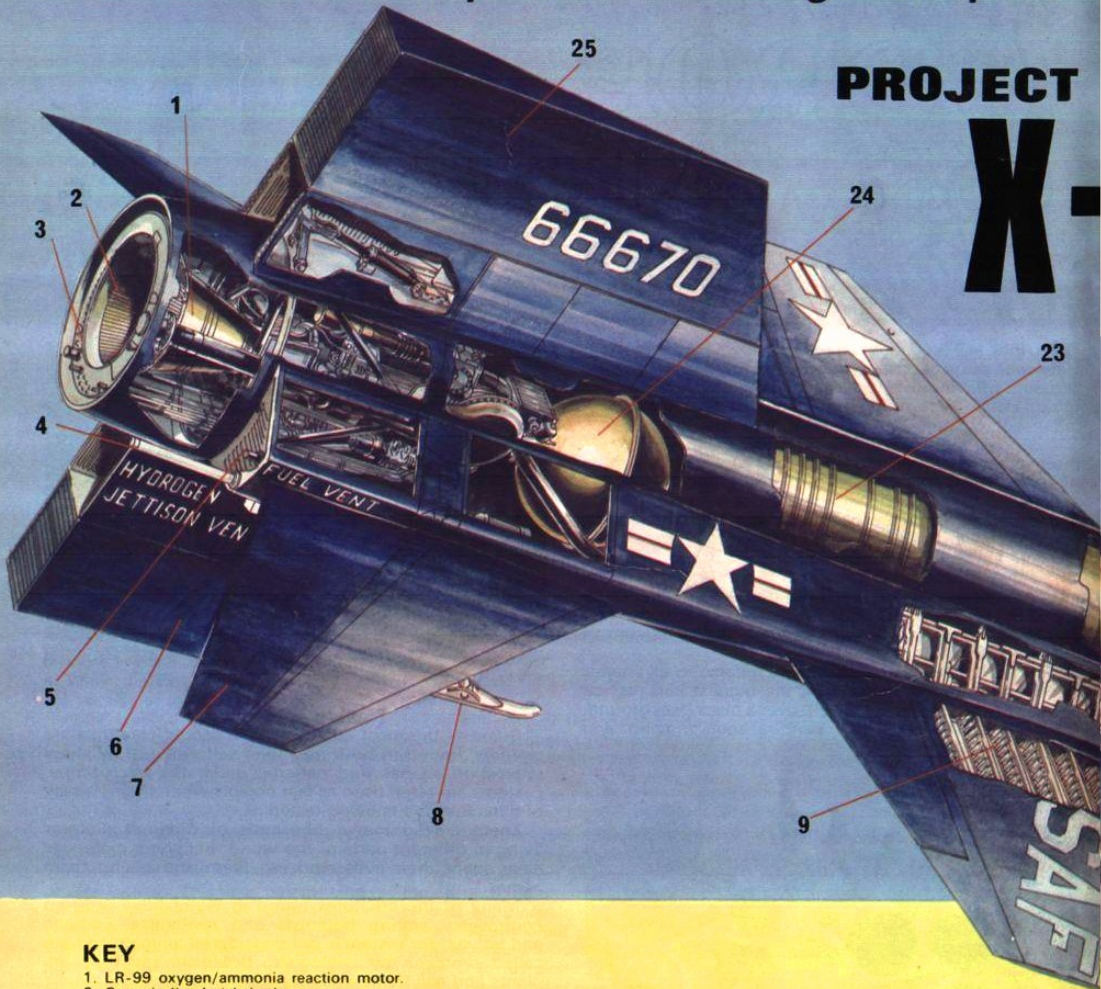
## KEY

- 1—pilot. 2—navigator. 3—radar screen and video screen. 4—double outer covering. 5—door closed—water intake. 6—door open—air intake. 7—hermetically sealed door which can be opened to let in air or water alternatively. 8—plastic fuel tanks. 9—nozzle that opens to expel stale air. 10—triple use fins: aileron, underwater rudder and air rudder. 11—directional rudder (for air and water). 12—turbojet. 13—electrojet. 14—starter-generator. 15—skis or skids, for take-off or sea-landing. 16—reserve oxygen. 17—electrojet batteries. 18—TV camera. 19—periscope. 20—air intake.



*It was shaped like a needle—this tiny plane that first pricked the fringe of space.*

# PROJECT X-15

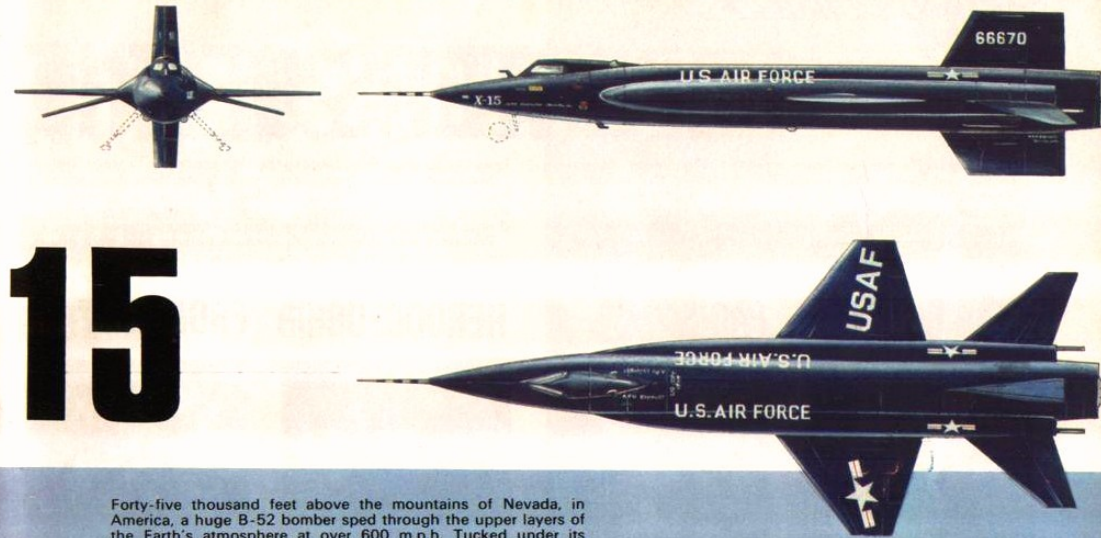


## KEY

1. LR-99 oxygen/ammonia reaction motor.
2. Ceramic-lined nickel tubes.
3. Flame shield.
4. Fuel jettison tube.
5. Fuel tank air vent.
6. Lower rudder jettisoned by explosive bolt.
7. Combined aileron-elevator.
8. Skid (shown dotted in illustration at top of facing page).
9. Multi-spar box construction.
10. Control jet nozzles for use above Earth's atmosphere.
11. Hydrogen-peroxide tank.
12. Nose-wheel.
13. Electrically-heated nose probe.
14. Control jet nozzles in top, sides and underside of nose.
15. Instrument panel.
16. Rocket-boosted ejection seat with all life support systems, stabiliser fins, anti-blast shield.
17. Instrument bag.
18. Colour cine-camera recording journey.
19. TV Camera.
20. Accessory power unit. The X-15 was above the atmosphere for most of the time,

which meant atmosphere could not turn fan or turbine to provide electrical power. This unit provided electrical power to the hundreds of instruments.

21. Liquid nitrogen.
22. Liquid oxygen tank.
23. Anhydrous ammonia tank.
24. Hydrogen-peroxide tank.
25. Moving rudder.



Forty-five thousand feet above the mountains of Nevada, in America, a huge B-52 bomber sped through the upper layers of the Earth's atmosphere at over 600 m.p.h. Tucked under its starboard wing was a tiny needle-shaped aircraft—the X-15 rocket plane.

Inside the cramped cockpit a test pilot watched his control panel. As all his warning lights flashed green, the X-15 dropped away.

Seconds later, its liquid-fuelled rocket engine burst into life, and half a million horse-power thrust the plane into space at almost 4,500 m.p.h. Within 80 seconds its eight tons of fuel were exhausted, but the X-15 continued to climb until it was 67 miles above the surface of the Earth.

Then began the most difficult task of bringing the X-15 back in a long engineless glide. Re-entering the Earth's atmosphere at too steep an angle, it would have burned up like a meteorite. Coming in at too shallow an angle, it would have travelled so far that it could not have regained the airfield. Thanks to the skill of the pilot and others like him, the X-15 landed safely.

Project X-15 began as long ago as 1953, and experiments were continued into the 1960s. A great deal was learned from them about how to control space vehicles in the airless region above our planet.

Without the work done by Project X-15, Man could never have realised his dream of reaching the Moon and setting foot upon it.

Dimensions: Length: 50 ft.  
Span: 22 ft.  
Height: 13 ft.  
Wing Area: 200 sq. ft.  
Weights: Empty: 16,000 lb.  
Launched: 31,275 lb.

Landing Speed: 205 m.p.h.  
Top Speed: Mach 7½  
Max. Height: 250,000–350,000 ft.



# CITIES IN SPACE

Scientists in America are working out plans for a science fiction type of scheme to house complete human communities in orbiting space worlds, possibly in the next twenty years.

**W**HAT use do you make of territory after you have conquered it? In the past, the answer has been to live in it. White men went in search of new lands and found Africa, America and Australia and turned these into thriving extensions of their own country.

Man has also conquered space, but the problem of what to do with that is difficult to solve. However, American scientists think that they have found the answer.

Think of a cylinder four miles (6.44 km) in diameter and 16 miles (26 km) long orbiting in outer space. Inside it would be a man-made mini-world with full-scale reproductions of Earthlike communities complete with houses, schools, shops, hills and valleys, trees and streams, roads and wildlife.

This is how some scientists in America propose to make use of the vast emptiness that surrounds the Earth. The cylinder would rotate to produce artificial gravity, but the people living in this space colony would not notice the motion, for everything would be just as it is on Earth with a few pleasant exceptions. There would be no bustling crowds, traffic jams, blaring car horns or fog.

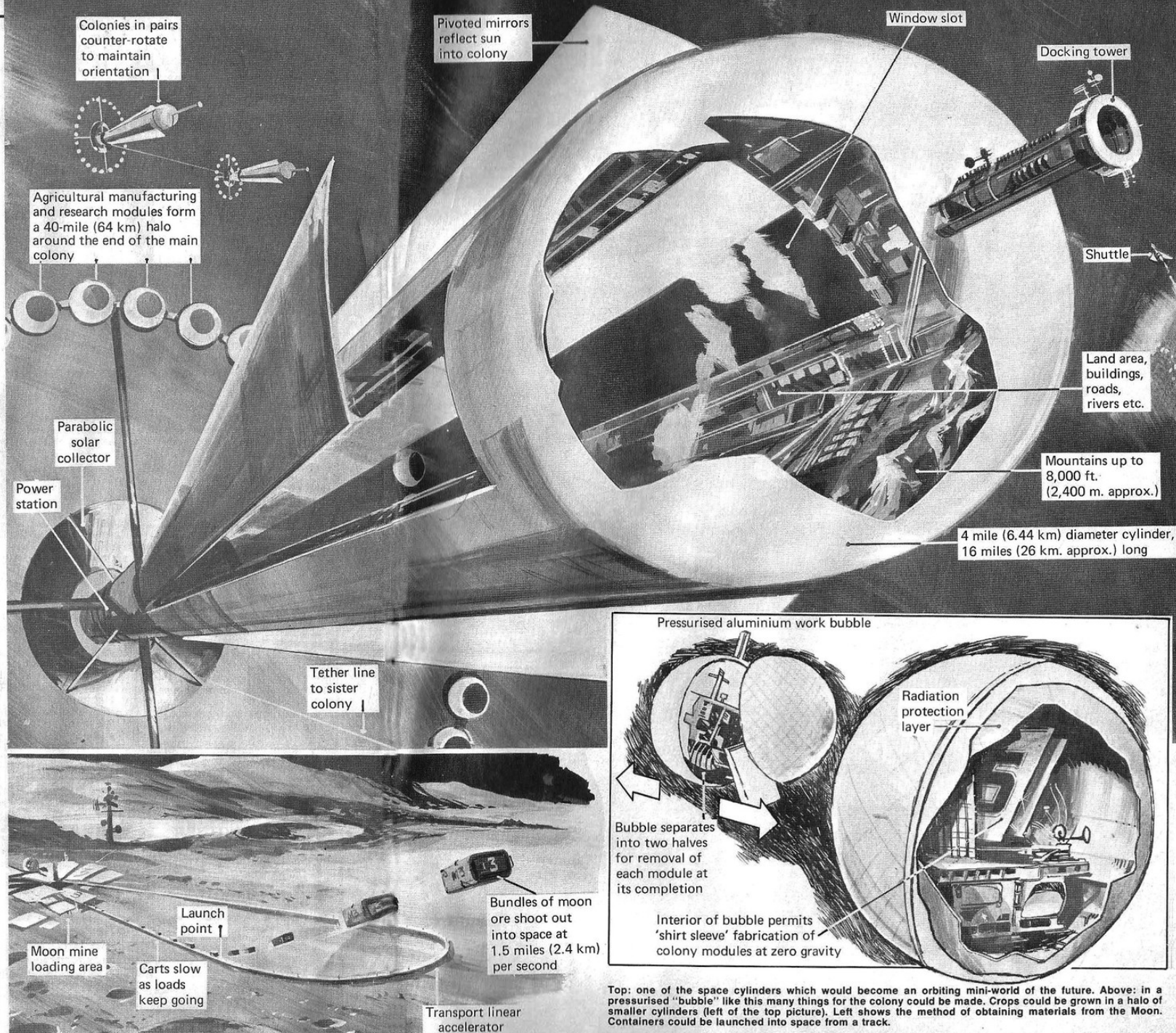
## A DREAM THAT COULD COME TRUE

The space colony idea began as an exercise for a group of physics students. At first it was regarded as a joke. But then they saw that these mini-worlds could really be constructed using only the materials and technical knowledge that already exist.

In charge of the project is Dr. Gerald K. O'Neill, professor of physics at Princeton University. He suggests that the first colony would be a small one of 10,000 people. From this would eventually come full-size space communities, with populations of 400,000, encircling the Earth.

Should a decision be reached to begin construction soon, O'Neill believes that the first of these space worlds could be in orbit in the late 1980s. But people will not be able to move in right away. It will take several years, with the use of electrical power from solar energy to get the great cylinders spinning at the correct speed and even longer, perhaps until the end of the century, to make them habitable.

However, in time, they would become self-supporting satellites, drawing upon the moon for their building material and launching this on its path by solar electric power, as shown in our picture on the far right. Science fiction writers have dreamed of such things, but this is a dream that *could* come true.



Top: one of the space cylinders which would become an orbiting mini-world of the future. Above: in a pressurised "bubble" like this many things for the colony could be made. Crops could be grown in a halo of smaller cylinders (left of the top picture). Left shows the method of obtaining materials from the Moon. Containers could be launched into space from a track.



# SPACE

## The Final Frontier

**Beyond the year 2000, the challenge of creating his own new worlds will lure man up into space and across the solar system**

THE precious moon ores are loaded aboard the spaceship. With a roar, it rises on a cone of flame from the grey planet and heads into the vast void. Its destination lies thousands of kilometres away — a space station spinning slowly on its own axis like a huge catherine wheel where scientists wait to process the lunar minerals before sending them to Earth.

Nearly two kilometres across, the space station encloses a man-made world with homes, laboratories, farms, and even lakes and rivers . . .

A tableau from a space fantasy film? No. This is really how the scientists of today foresee the space worlds of tomorrow. Within the next 20 years, they predict, man will set up a moon base.

Thousands of people will leave this teeming world with its rising population and colonise huge space stations. Like the questing pioneers of old who sailed off across uncharted oceans, they will be carried aloft in spaceships into the unknown heavens and send back to Earth new sources of power and minerals.

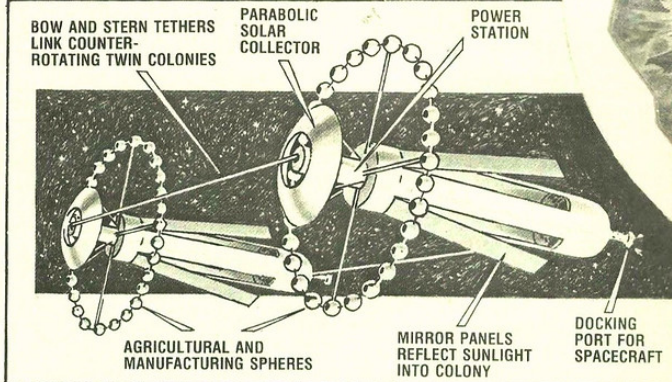
Professor Gerald K. O'Neill, of Princeton University, who heads a group of physicists designing solar satellites, has estimated that a space colony accommodating 10,000 people could be built by 2025. He was among some 30 scientists who met two years ago to study the industrialisation of space.

Their amazing conclusion was that a 500,000-ton wheel-shaped habitat over a mile (1.6km) in diameter could be built somewhere along the moon's orbit. The wheel would rotate around its hub at one revolution a minute — fast enough for the centrifugal force on the inhabitants to simulate their weight on Earth.

On the rim of the space station would be accommodation for 10,000 people, with shops, schools, hospitals, light industry, farms and an earth-like environment and atmosphere. Interior views up to half a mile away would be created, embracing scenes of trees, flowers and rivers. Heavy industry would be carried out outside the station, making use of the weightlessness and high vacuum of space.

According to the space scientists, the principal industries would be the processing of moon materials and the manufacture of other space stations and solar satellites to be put in orbit around the Earth. Workers would be buzzed from the station to their "work sites" in small spaceships.

America's Apollo moonshots of the last



Space colonies orbiting the moon, 25 kilometres long and 6 kilometres in diameter, would be tethered in pairs. To maintain their positions in space, they would rotate in opposite directions, the spin also providing gravity for the inhabitants.

decade revealed that lunar materials contain from 20 to 30 per cent metals, 20 per cent silicon and considerable amounts of oxygen. About 150 people on the moon could mine about one million tons of these ores each year and ship them to the space station. There they would be refined to extract aluminium and, perhaps, titanium for building materials, silica for glass and oxygen for hospitals, rocket fuel and other purposes.

### Intensive Farming

There would also be intensive farming in the space station because grains and certain other plants grow faster with the more light they receive. A space farm could be provided with up to 24 hours a day sunlight and the concentration of carbon dioxide and water vapour would be adjusted to produce greater yields.

Vegetables, cereals, poultry, ham and dairy products for a population of, say, 10,000 people could be grown on an area of about 111 acres, which would also support rabbits and 2,800 head of cattle.

Eventually, according to Professor O'Neill and his colleagues, the asteroids themselves would be exploited for the ele-

ments of carbon, nitrogen and hydrogen which are scarce on the moon but vital for human life.

A typical asteroid is a lump of rock about 40 kilometres across: there are thousands of them in the solar system. With the elements they contain, space scientists claim that colonies could be built with a total land area 3,000 times that of Earth. Eventually the size of individual colonies could be extremely large — huge spherical stations with 20-kilometre diameters, containing a land area of 650 square kilometres.

As with most plans on Earth, it will also be very expensive. The total cost of the first colony including all the development work is estimated at £50,000 million, over twice the outlay on the Apollo flights.

Nevertheless, the American scientific team remain optimistic. Their report summed up the future like this. "Space colonisation may offer a way to bring new wealth to the Earth and new opportunities to its people, without the environmental damage which has so often accompanied growth in the past."

**NEXT WEEK: When The Tide Comes In: harnessing the energy of the sea.**

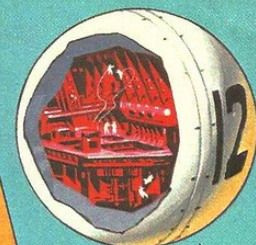
WILF HARDY



Each colony would have its own atmosphere, with sunlight reflected in by giant mirrors. Real "weather", day and night, and seasons would be possible with full control of the elements.

Only two per cent of the colony's building materials would come from Earth. The rest would be mined on the moon and shot up into orbit by solar-powered electromagnetic launchers.

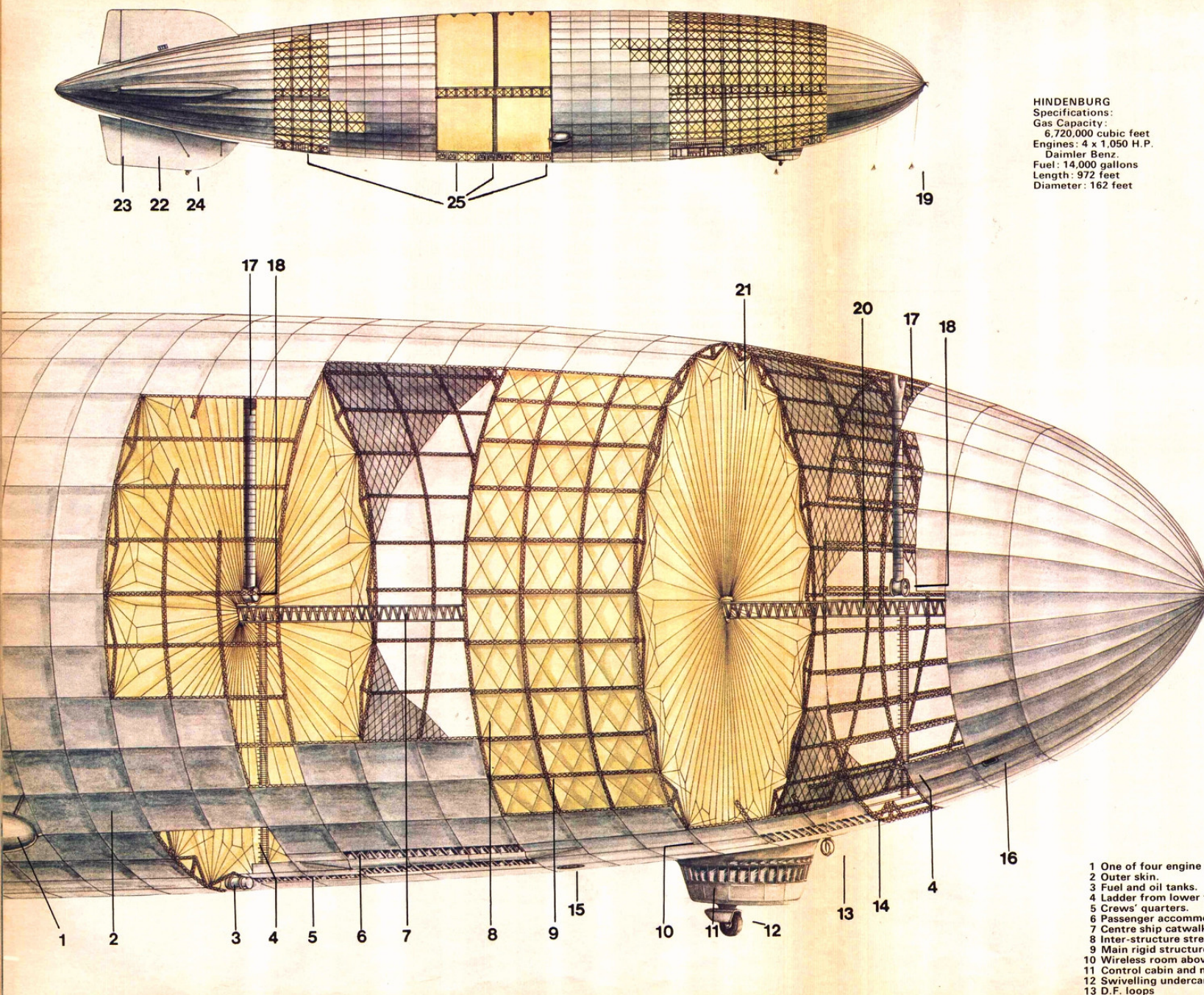
Manufacturing spheres would be made to split apart to release completed machinery modules. Each independent sphere would be a specialised unit for animals, crops, metalwork or chemicals.





# FLYING CIGARS

**HINDENBURG**  
Specifications:  
Gas Capacity:  
6,720,000 cubic feet  
Engines: 4 x 1,050 H.P.  
Daimler Benz.  
Fuel: 14,000 gallons  
Length: 972 feet  
Diameter: 162 feet



One of the most awe-inspiring of man-made machines must have been the giant airships which were in service between 1900-1937. Developed first of all for war purposes, rigid and non-rigid airships were used by the navies of U.S.A., Germany, France and Britain. Their main function was sea reconnaissance, but during the First World War German Zeppelins bombed England. Although accidents and enemy action resulted in heavy losses, the Germans persevered.

Count Ferdinand von Zeppelin built his first airship in a floating shed on a lake near his home at Friedrichshaven in 1899. It was 420 feet long, 38½ feet in diameter and contained 400,000 cubic feet of hydrogen. Driven by two engines of only 15 H.P. it was hopelessly underpowered. L.Z.1 as it was called (Luftschiff Zeppelin 1) used money faster than gas and petrol and was broken up in 1901.

The year 1905 saw the Count at it again when L.Z.2 was built. On her second flight she was blown away by strong winds and after a safe landing was destroyed at her moorings. With his last money the once wealthy Count built L.Z.3 and at last convinced the German High Command of its military possibilities after a flight lasting eight hours.

The Count later formed Germany's first airline operating airships and by August 1914 more than 10,000 passengers had been carried 107,231 miles on 1,588 voyages.

The British had not been idle during this period, although they only had seven in commission at the beginning of the war. By 1918 over 100 were in use. Of these, the largest was the R.33 class, 643 feet long. The longest German airships during the war were 693 feet. Italy, France and America also had considerable numbers in service, although they were generally much smaller.

Regardless of the number of airships that crashed or burned without the help of bullets, shells, storms etc., the U.S.A., Germany and Britain continued to build airships. Those of Germany and Britain were for the rich Trans-Atlantic trade in passenger carrying, and in 1919 a British airship became the first to cross the North Atlantic.

Improved engines and stronger structures led to the Germans and British building more comfortable and luxurious ships capable of carrying more passengers over greater distances. The "Flying Cigars" seemed here to stay.

However, the loss of the British R.101 at Beauvais in France in 1930 and many other near disasters started a general feeling against the airship. A structure the size of an ocean liner at the whim of wind and weather must have limitations and these showed up terribly in 1937 when the L.Z.129 *Hindenburg* exploded with terrible loss of life as it arrived in the U.S.A. after a Trans-Atlantic flight.

This put the seal on the death warrant of the airship as a passenger carrier. People saw the film of the *Hindenburg* burning, and that was that.

The Second World War saw limited use of "Blimps" as they were called, used for anti-submarine work off the U.S. coast. A U.S. Navy airship, Z.P.G.-2 holds the world record for staying aloft—cruising around for eleven days!

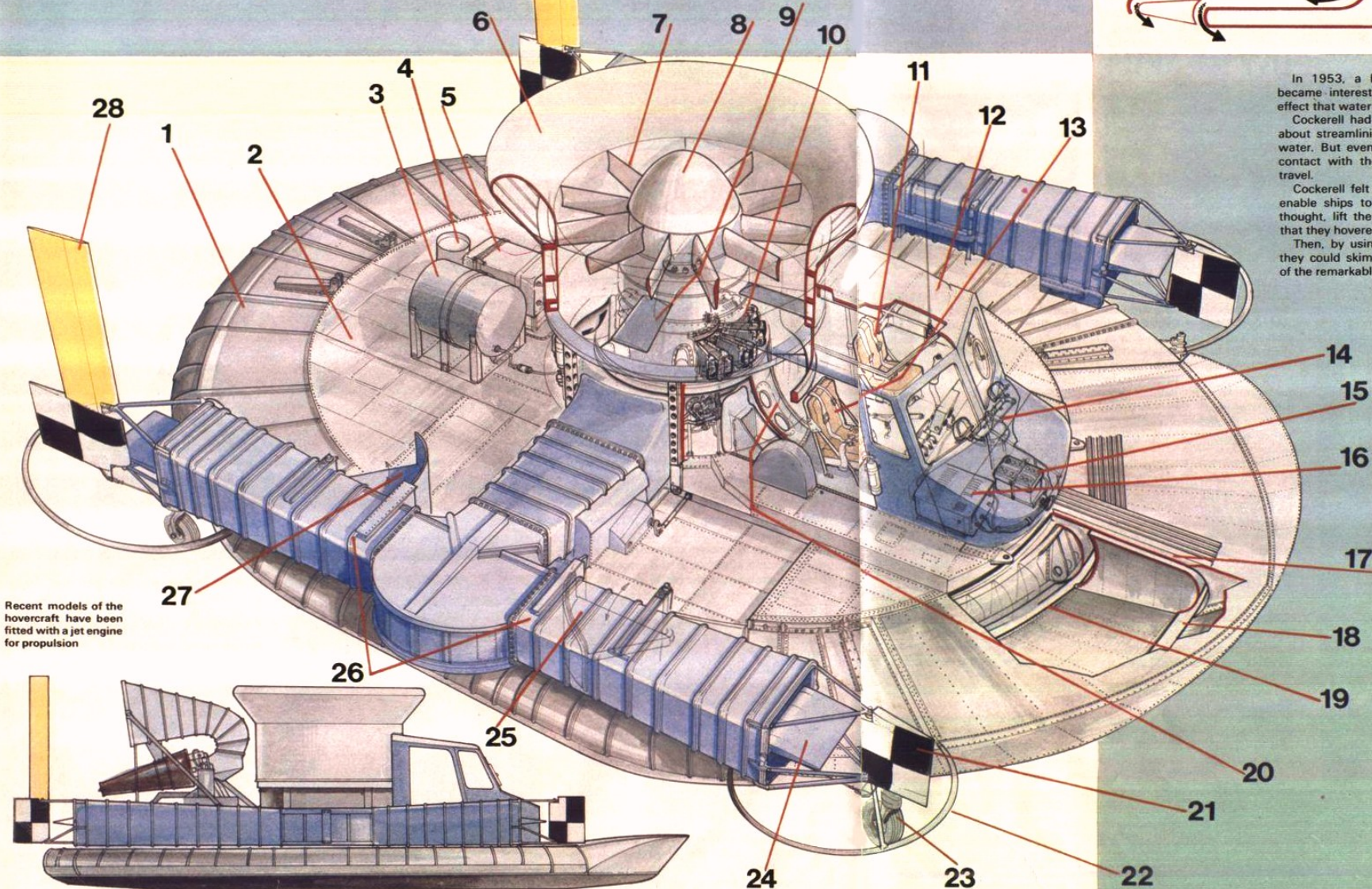
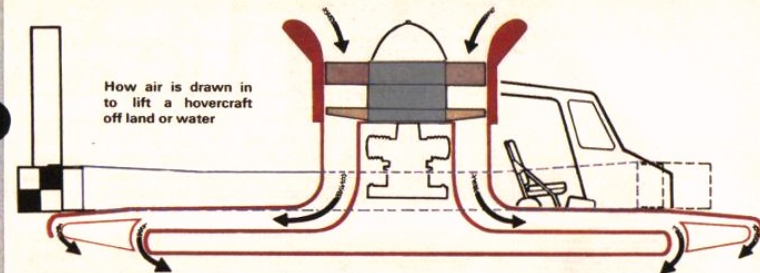
But the airship may not yet be dead. Even now a firm in the U.S.A. is looking into the possibilities of using a triple-hulled airship for cargo carrying.

- 1 One of four engine pods or cars.
- 2 Outer skin.
- 3 Fuel and oil tanks.
- 4 Ladder from lower to centre catwalks.
- 5 Crews' quarters.
- 6 Passenger accommodation.
- 7 Centre ship catwalk.
- 8 Inter-structure stress wires.
- 9 Main rigid structure.
- 10 Wireless room above control room.
- 11 Control cabin and navigation room.
- 12 Swivelling undercarriage.
- 13 D.F. loops

- 14 Officers' quarters.
- 15 Searchlights.
- 16 Emergency water release.
- 17 Gas shaft/exit to atmosphere.
- 18 Gas valve.
- 19 Retractable aerials.
- 20 Forward catwalk.
- 21 Tangential stay wires.
- 22 Fin.
- 23 Rudder.
- 24 Tail Wheel.
- 25 Fuel tanks all along underside.



# Sailing on Air



Recent models of the hovercraft have been fitted with a jet engine for propulsion

In 1953, a British electronics engineer named Christopher Cockerell became interested in the age-old problem of trying to reduce the 'drag' effect that water has on the hulls of ships at sea.

Cockerell had a small boat-building business, so he knew a great deal about streamlining, and how it helped vessels to slide more easily through water. But even with the best streamlined shapes, the water was still in contact with the hulls and set a limit on the speed at which they could travel.

Cockerell felt sure there must be something more that could be done to enable ships to travel faster on the surface of the oceans. Why not, he thought, lift them just a foot or so off the surface on a cushion of air so that they hovered above the wave tops?

Then, by using aircraft-type propellers instead of propellers in the sea, they could skim along comfortably clear of any drag effects. Thus the idea of the remarkable hovercraft was born.

Great improvements have been made on the first experimental hovercraft designed by Christopher Cockerell, but the principle on which they are based remains unchanged. Powerful fans mounted on top of the vessels suck in air from above and blow it out through a wide slit beneath a sausage-shaped balloon made of tough rubber material that goes all round the outer edge of the vessel.

The fans produce the cushion of air which keeps the hovercraft clear of the surface of the water. When the fans are switched off, it sinks gently down and floats like any other ship.

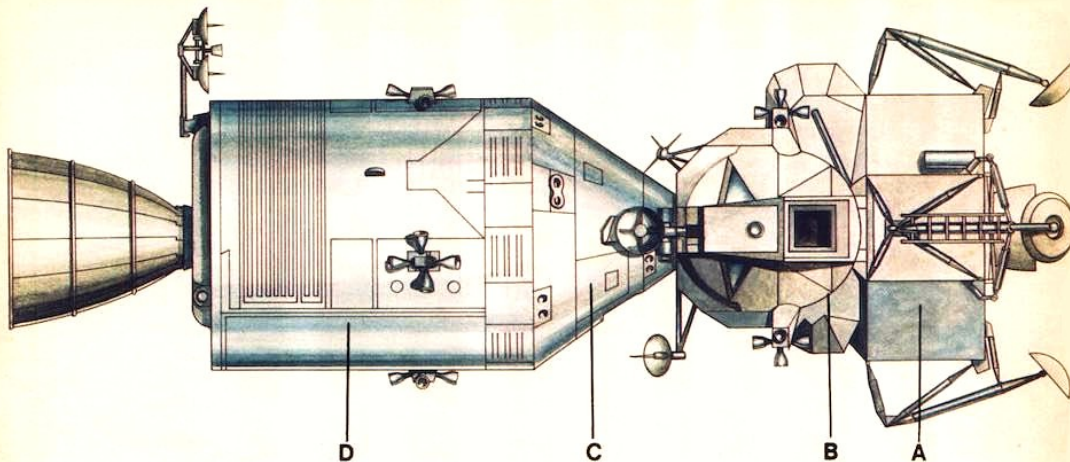
This air cushion enables a hovercraft to operate equally well over swamps or sand dunes.

These wonderful vessels—half ship, half aircraft—are operating in many parts of the world, and huge 165-ton models are now being used to carry up to 30 cars and 250 passengers between Britain and the continent of Europe. Already being planned are even larger ones which one day may be able to cross such mighty oceans as the North Atlantic.

## KEY

1. Buoyancy Tanks.
2. Rear Deck
3. Petrol Tank (30 galls.)
4. Oil Cooler
5. Oil Tank (9½ galls.)
6. Duct which draws in air, constructed from light alloy with inner plywood formers
7. Wooden guide-vanes which 'straighten' air flow
8. Centre fairing
9. 4-blade fixed pitch air-screw
10. Alvis-Leonides 520-540 BHP aero engine
11. Pilot's seat
12. Cockpit roof with radio aerial
13. Observer's seat
14. Rudder bar
15. Battery
16. Radio
17. Narrow duct through which air flows to:
18. Outer annulus (duct through which the air is forced)
19. Inner annulus
20. Air intake for engine
21. Rudders on all 4 corners
22. Protection rails for fragile rudders
23. Ground handling wheels on each corner
24. Elevation at each corner to lower or lift according to conditions
25. Drawn in (in closed position) is the air duct valve seal which prevents propulsion air from blowing out of the front, causing the vehicle to 'brake'
26. Propulsion air duct through which air is blown to push the SRN-1 forwards or backwards
27. Air duct valve seal shown in open position
28. As vehicle always moves faster forward than astern, large area rudders are essential.





**The rocket that took them into space was powerful and enormous. The vehicle that brought them safely back was little more than a midget.**

When an explosion took place in the service module of Apollo 13 and destroyed its engine, it was only by the greatest good fortune that America's space mission was on its way to the Moon and not returning from it.

As we saw last week, if the crew had taken off from the Moon in the lunar excursion module *Aquarius*, having used its motor for descent and landing, the mission would have had no engine to blast the three astronauts out of orbit round the Moon and back on a course to Earth.

As it was, the comparatively small but powerful motor of the L.E.M. was sufficient to ensure the rescue of Mission 13.

With only a few small course corrections, the flight back to Earth went perfectly.

But it was not concern about the motor so much as other problems that worried the astronauts. The air they were breathing was one such problem. Stale air has to be "scrubbed" and used again, usually done by a chemical called lithium hydroxide which washes the air and stops the crew gassing themselves. But the system did not seem to be working properly.

To overcome this difficulty, the underwear of the astronauts was cut up under instructions from Houston and stuck together with sticky tape. After hours of "do-it-yourself", the crew managed to build an air cleaning system. Leaks were patched up with a sock, a towel and bits of sticky tape. It worked, it was a very near thing.

Another worry was the fact that the service module, where the explosion had occurred, was showing signs of breaking up. "Snowflakes"—possibly pieces of disintegrating material—passed the windows of the command module and the craft began to develop a wobble. Then a thump and other noises also strained the nerves of the crew.

All sorts of gimmicks and ideas poured into the control centre from the astronauts on the ground who worked on simulators and similar spacecraft to try and visualise what they would do in a similar situation. Their suggestions proved invaluable.

The guidance system, too was proving difficult, and the heat shield which would stop the crew frying on re-entry was possibly cracked.

Cooling water and drinking water was another problem. There was not enough of either, and the drinking water was possibly contaminated.

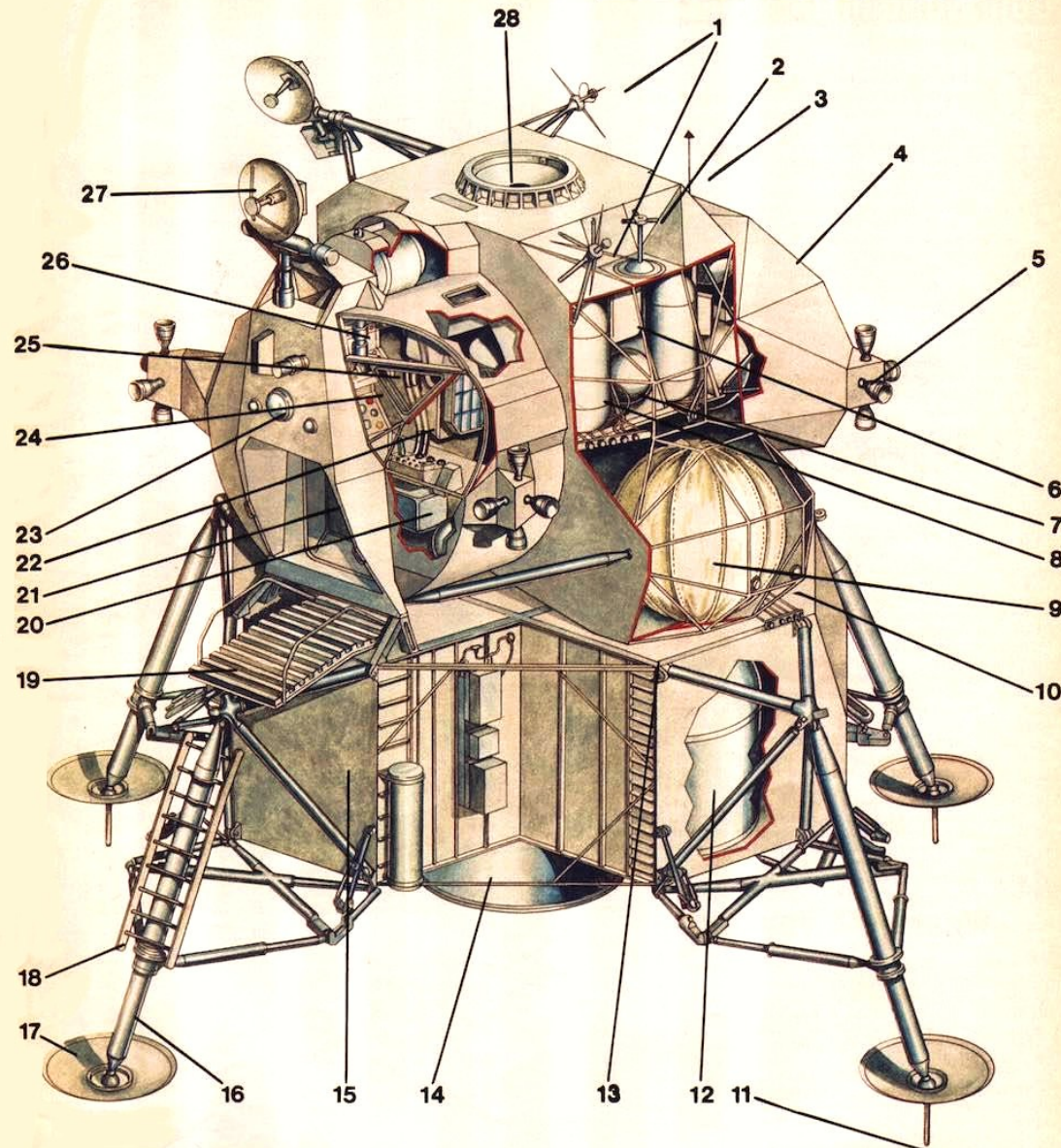
All the odds seemed stacked against Apollo 13 returning. But, as we now know, one of the world's largest T.V. audiences watched as the craft dropped through the clouds on its giant parachutes and splashed down just 600 miles from Samoa. After all they had been through, they were only five seconds late, and four miles from the point the computers said they would splash down.

This week, we take a look inside the mighty midget that saved the three astronauts—the first "lifeboat" in space.

Above: Apollo Spacecraft and Lunar Excursion Module in rendezvous position. A Lunar excursion module descent engine and launch pad. This is the engine which was used to blast the "13" crew back to Earth. B. L.E.M. upper half, which the astronauts used to stay alive. C. Command module. D. Service module which went unserviceable because of an explosion.

## LUNAR EXCURSION MODULE

1 Very high frequency antenna. 2 Docking target. 3 Extra vehicular activity antenna. Astronauts can talk from their space suits through radio contact, using this aerial, to Earth control and then to our radios and TV sets. 4 Aft equipment bay. 5 Reaction control assembly. These controllable rockets make the craft roll, move sideways, tilt or whatever the pilot dictates. 6 Assembly fuel tank. 7 Assembly helium tank. 8 Assembly oxidiser tank. 9 Fuel tank. The L.E.M. is split into two separate items. The top half takes off from the Moon with its own engine leaving behind the lower half. (See A and B—small illustration.) 10 Docking light. 11 Lunar surface sensing probe (on 3 of 4 undercarriage legs). These shut off engine when L.E.M. gets to within two feet of lunar surface. 12 Main engine fuel tank. 13 Lower half of L.E.M. (A on small illustration acts as launch pad when crew leaves Moon.) 14 Main descent engine skirt. 15 Oxidiser tank in this compartment. 16 Telescopic landing gear leg. 17 Landing pad. 18 Ladder. 19 Egress platform. 20 Water tank. 21 Main door. 22 Crew umbilicals. When operating, craft crew plug in to these tubes for all services: oxygen, electrical heating, etc. 23 Tracking light. 24 Control panel. 25 Window (2 more not seen). 26 Optical telescope. 27 Rendezvous radar antenna. 28 Entrance to L.E.M. when attached to command and service modules—as in small illustration.



# THE FIRST 'LIFE BOAT' IN SPACE



# Hide~And~Seek Hunter

The Polaris submarines keep a 24-hour watch for the threat of possible attack

DEEP in the waters of the North Sea, the Royal Navy's nuclear submarines stand guard over our shores. Always on patrol in the seas around Britain, they are this nation's nuclear deterrent force. For this purpose, they are equipped with Polaris ballistic missiles, which have nuclear warheads.

Typical of them is HMS *Resolution*, the vessel shown below. Launched in 1960, it carries 16 Polaris missiles and six torpedo tubes. Powered by its nuclear reactor, which creates heat to operate a steam turbine, it can cruise at 25 knots. Its missiles are fired underwater, propelled by two-stage rockets which carry them through the air towards their target up to 4,000 kilometres away.

Because of the size of their engines, crews and missiles, nuclear submarines have to be very large; HMS *Resolution* displaces 7,500 tons and is 140 metres long.

The missiles are over nine metres high and need a great deal of equipment to manage their navigation, fire control and tracking. Much of the rest of the space in the submarine is taken up by the nuclear reactor, which is heavily insulated, and the heat exchanger, which generates the steam to drive the main turbines. Their power is transmitted through reduction gearing to the propeller shaft.

The submarines are capable of remaining at sea for up to 90 days, but 60 days is the normal duration of a patrol. Towards the end of that period, the nervous strain of living so long in a confined space without daylight begins to tell on the crew. Enough food is carried to enable the patrol to be extended if necessary, and endless supplies of air for breathing and fresh water for drinking and other purposes can be obtained from sea water.

Each submarine has two crews. When a submarine returns from a patrol, the crew go on

leave. A second crew starts to get the submarine ready for its next patrol, a task that takes a month. Near the completion of this period, it will receive help from the crew it relieved.

The normal cycle is that while one submarine is at sea, a second is almost ready to begin a patrol, while a third will have just returned from duty at sea. The fourth could be in dock undergoing its regular maintenance, known in the Royal Navy as a refit.

Nuclear submarines are among the latest in a long line of underwater vessels. Their story really begins in the second half of the 16th century, when an Englishman, William Bourne, created the design for a ship to travel under the sea. His plan was for a vessel with an inner hull of greased leather that could be stretched inwards or outwards to expel or admit water between itself and the wooden side of the vessel. Air was taken in through a hollow mast.

## Sub With Oars

Cornelius van Drebbel, a Dutch physician, improved the design in 1620. He used an ordinary rowing boat, with the top covered over, and leather to control the amount of water let in. Drebbel also had a device for sucking in fresh air and pumping out stale air. With six oars flapping like fins, he was able to carry passengers down the Thames, with nearly all the boat underwater.

Various other attempts to design a submarine followed. One of them was by Robert Fulton, an American. In 1800, Fulton used his submarine to blow up a hulk in Brest harbour.

Walter Delancy, a Chicago engineer, patented a submarine in 1859. In the centre were two steel tanks, one holding water and the other compressed air. By pumping water into or out of the first tank by compressed air, the

buoyancy of the vessel could be adjusted to various depths.

During the American Civil War, John David, a Confederate naval officer, built a submarine for use against the Federal squadron blockading Charleston. Eight men turned the propeller of this craft, which in 1863 successfully sank a Federal warship.

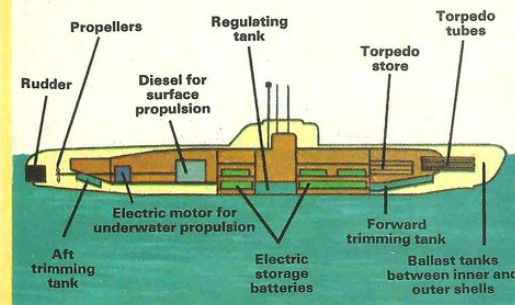
In 1885, a Swede, T. Nordenfeldt, designed and built six submarines driven by electric motors. They dived or surfaced by filling or emptying ballast tanks. John P. Holland built a submarine in 1895, which was propelled by steam on the surface and by electric motors when submerged.

The British Admiralty ordered five Holland submarines in 1900, and from them was developed a submarine which was entirely British in design and construction. It was the first to be fitted with a periscope for observing the surface while submerged. Germany did not build her first submarine until 1906, being the last of the naval powers to adopt this type of warship — though she made wide and deadly use of them in both World Wars.

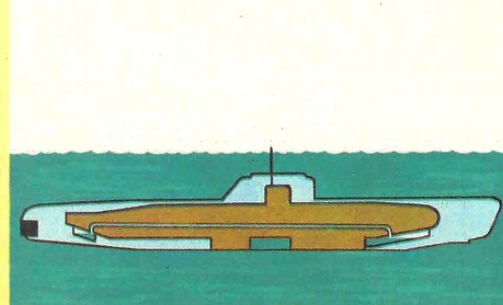
By this time, diesel engines were in general use for propulsion on the surface, battery-driven electric motors being retained for submerged operations.

With these developments, the construction and operation of submarines became standardised. Until the later stages of the Second World War, the submarine was much the same kind of boat as in 1900. The chief improvements were in size, speed and armament.

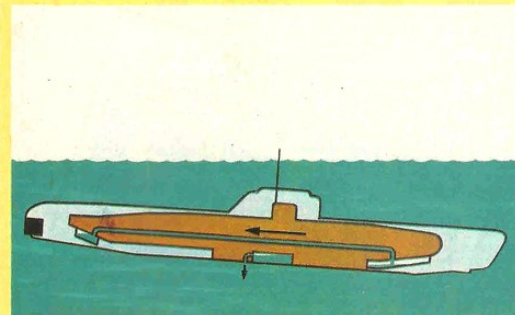
The first nuclear submarine was finished in 1955, and in 1960 one went around the world submerged for the whole time. This facility, aided by their nuclear armament, makes modern submarines vital factors in this and other nations' defensive forces.



The layout of conventional submarines is shown by this German U-boat, class XX1, built between 1944 and 1945. These pictures show how such a boat submerges. On the surface, the ballast tanks are empty.



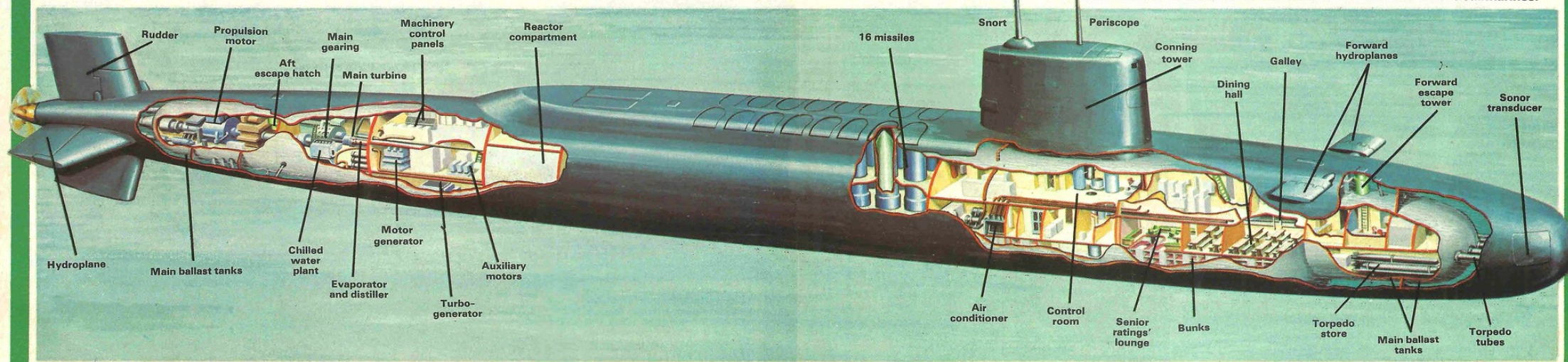
Before diving, water is let into the tanks through lower valves, and the air escapes through upper valves. Water is admitted until the vessel weighs as much as the water it displaces.



The slightest change in weight, fore or aft, causes the boat to alter its position. This is counteracted by pumping water either to the forward or after trimming tanks. The submarine's weight is regulated by the amount of water pumped into, or out of, the tanks. For steering, the craft uses hydroplanes and a rudder.

Illustrated by Clifford Meadway

## HMS Resolution One of Britain's four Polaris ballistic missile submarines.





# One out of every six ships on the high seas is an oil tanker

## SEA GIANTS

Geared steam turbine engines are usual in oil tankers. Speeds range from  $11\frac{1}{2}$  to  $16\frac{1}{2}$  knots. A giant among them is the s.s. *British Admiral*, which you can see on these pages.

It has a deadweight of 100,000 tons. Deadweight tonnage is the weight of the cargo, stores, water bunkers and fuel needed to drive the ship.

Gross tonnage is arrived at by measuring the enclosed space below deck in cubic feet and dividing by 100.

Japan has an even bigger tanker, the *Tokyo Maru* with a deadweight of 150,000 tons. Key to the picture: A. Anchor winches. B. Fore and aft gangway. C. and D. Cargo manifold (for loading and discharging). E. Cargo tanks. F. Cargo pipelines. G. Oil fuel bunker tank. H. 2nd engineer's day room. J. Captain's bedroom. K. Navigating bridge. L. Radio room. M. Swimming pool. N. Officers' cabins. O. Chief engineer's day room. P. Hospital. Q. Galley. R. Crew's recreation room. S. Boiler room. T. Store room. U. Steering gear. V. Engine room. W. Propeller shaft.

tons, had been spilling its cargo of crude oil into the Atlantic. Attempts to tow the ship clear had failed.

So, once the crew were safely away, the tanker was bombed by the R.A.F. and Royal Navy to burst open its tanks. Petrol and fire bombs were dropped to set the oil alight before it could clog up beaches or kill wildlife. At one time, a stretch of sea over a mile wide was blazing.

Finally, the job was finished. The shattered *Torrey Canyon* was safe enough to be handed over to the salvage teams—an empty shell of creaking, groaning metal.

This is the sort of story about oil tankers

that usually makes the big headlines. Because it has such drama and excitement, it claims the front pages of all the national newspapers for a few days.

## Valuable Cargo

Perhaps reading such a story was your first introduction to oil tankers, but happily it is not the most common. And though the more solid, day-to-day story does not make the headlines, it is nonetheless worth telling, for without tankers our lives would be uncomfortable to say the least.

Oil is the most valuable cargo carried by

sea. And the sea mammoths which carry it are the largest man-made vessels afloat.

They carry millions of tons of fuel each year from oilfields in the Middle East and elsewhere to Europe. Most of the world's oil wells, other than those of the U.S.A. and Russia, are thousands of sea miles from the oil-using areas.

So, oil has to be moved either through a pipeline or in a tanker. Except in overland conditions which are particularly favourable to pipelines, tankers are best for long distances. They are cheaper than pipelines and can go where they are needed.

Today, one out of every six ships sailing

